WILSON'S

CYCLOPÆDIC PHOTOGRAPHY

A COMPLETE HAND-BOOK

OF THE TERMS, PROCESSES, FORMULÆ AND APPLIANCES
AVAILABLE IN PHOTOGRAPHY,

ARRANGED IN CYCLOPÆDIC FORM

FOR READY REFERENCE.

BY

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The camera is mightier than the pen or the pencil.

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This Work

IS DEDICATED WITH ALL KINDLY FEELINGS

TO THE PHOTOGRAPHERS IN MY OWN COUNTRY AND ABROAD,

WHO, FOR OVER THIRTY YEARS,

HAVE UPHELD ME IN MY EFFORTS TO HONOR OUR ART;

NOT FORGETTING

ALL THOSE WHO HAVE FALLEN INTO THE RANKS MEANWHILE,

AND WHOSE COÖPERATION IS ALWAYS SO

GRATEFULLY WELCOMED BY

Edward L. Wilson.

PREFACE.

In the earlier works of the author promise has been made that as time went on the interesting and valuable facts and formulæ available in the practice of photography should be collated, composed, and carefully edited, until a want arose for a book for all time—namely, a dictionary or an encyclopædia, or whatever one may wish to call it.

Surely the day has arrived when the photographer needs whatever may save his time and assist his revenue, for he must do much more to please his patrons and add to his purse than was required of him a few years ago. He has not the time nor the inclination to search the many valuable treatises upon our art. Illustration and definition must come to his aid.

Consequently, the present volume is offered with the belief and hope that the facts contained therein will serve a useful purpose to the earnest worker and the interested student in photography. It is for these only that I labor.

Brevity and simplicity have been followed in the preparation of this work, except in cases where history needed to be preserved and when details only would serve.

I have drawn from a thousand authors. I have filtered and reduced as carefully as my judgment would allow, and I have no doubt I could do better should I begin at once and do it all over again. I commend it to the craft as it is, however, with the full knowledge of the fact that in a work like this, including such a multiplicity of subjects, kind indulgence must be asked for the numerous errors that even the most painstaking care must have overlooked.

EDWARD L. WILSON.

NEW YORK, October 1, 1894.

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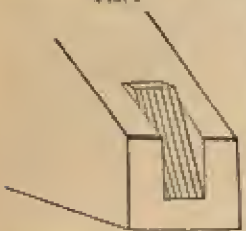
WILSON'S CYCLOPÆDIC PHOTOGRAPHY.

Abate. To steep in an alkaline solution.

Abat-jour. Any contrivance or apparatus to admit light, or to throw it in a desired direction, as a lamp-shade. 1. A skylight, or any bevelled aperture made in the wall of an apartment or in a roof for the better admission of light from above. 2. A sloping, box-like structure, flaring upward and opening at the top, attached to a window on the outside for the purpose of directing light downward into the window. The abat-jour form of skylight is used by many photographers.

Fig. 1.

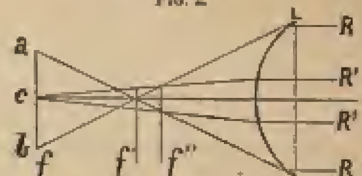


Aberration. Many people suppose that with lenses small in relation to their focal length, all rays coming from one point are refracted by the lens into one point again. Such is not the case in practical optics, as rays coming from one point, in some cases are no longer collectible in one point. This optical defect gives the different aberrations known as spherical and chromatic aberration, curvature of field, distortion and astigmation.

The marginal parallel rays *R R*, passing through a convex lens *L*, cross the axis at *f′* nearer to the lens than the more central ones *R′ R′*, which cross at *f*. This is a result of the spherical surface of the lens, and is called spherical aberration.

If we present a convex, short-focus lens to solar rays, and produce a sharp image of the sun on a piece of white paper, we will find that the image at *f*, which is the one made by the central rays (and therefore is the sharpest), is surrounded by a halo, *a b*, which is what we call the lateral spherical aberration. This halo is produced by the shorter marginal rays *R R*, after crossing the axis, diverging, and it is also called the circle of aberration. *f′ f*, the distance of the difference of the central and marginal rays, constitutes the longitudinal aberration. The

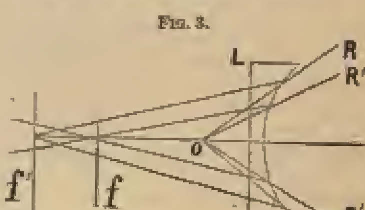
Fig. 2.



least spherical aberration is where the two cones intersect each other between *f″* and *f*. This aberration is called positive.

If converging rays *R R* and *R′ R′* (Fig. 3) which we suppose would be collected in the point *o*, fall on a concave lens, the marginal rays *R R* are refracted more strongly

Fig. 3.



than the more central ones *R′ R′*, and thus *R R* will cross the axis farther from the lens, at *f′*, than the more central ones, *R′ R′*, which cross the axis at *f*. In this case the spherical aberration is of the opposite character, and is called negative aberration. It is evident, from the foregoing, that spherical

aberration varies with the aperture of the lens and the material of which the lens is made. Therefore, the larger a lens is in proportion to its focal length, the greater its spherical aberration. A lens of an aperture, say, of one-fiftieth of its full length, has no perceptible spherical aberration. The longitudinal spherical aberration increases as the square of the diameter of its aperture, and inversely as the square of its focal length. Thus, if we have two lenses of the same curvature, made of the same material, but the one of twice the aperture of the other, the longitudinal aberration of the larger one is four times as great, and the lateral, or circle of aberration is eight times as great as that of the smaller one.

Absorption of Light is the process which takes place when light enters an imperfectly transparent medium, a portion of the light being diffused through the medium, or absorbed, while the remainder is transmitted after one or more internal reflections. The study of the laws of light-absorption forms the basis of photo-spectroscopy. To the photographer the subject is chiefly interesting in its bearing upon the rapidity of the photographic objective. The degree of light-absorptive power of an objective depends upon the transparency of the kinds of glass used in its construction, the perfection of the surface polish, the thickness and tint of the glass. The lighter kinds of flint glass allow two or three times as much chemical light to pass as the heavy kinds which have a yellowish tint, and one and a quarter times as much as the crown glass which has a greenish tint. The new Jena glass, now so largely used for lens-making, absorbs only a minimum amount of light, being almost colorless, hence the rapidity of lenses made of this glass.

Accelerating. In photography, the means of quickening the operations of light upon the daguerrotype or glass plate or upon photographic paper.

Accelerator. Any substance employed to quicken the action of the developer; generally used in reference to gelatine dry plates. In alkaline development the alkali is the accelerator; with hydroquinone a few drops of oil of turpentine are suggested; with ferrous oxalate, hypo-soda is advised. For use either with pyro or ferrous oxalate Himly recommends a new accelerator compounded as follows:

A.	Water	500 parts.
	Zinc filings	100 "
	Sulphuric Acid	50 drops.

This solution is well shaken and kept for some days in a stoppered bottle, then are added 250 parts of sodium sulphite; when this is well dissolved it is allowed to stand a few days.

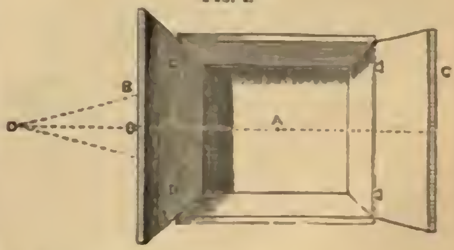
B.	Water	500 parts.
	Sulphite or Sulphate of Ammonia	250 "

The solution is filtered and solution A mixed in equal parts with B. This forms the stock solution. When used with pyro add 1 part sulphocyanide of ammonium to each 50 parts accelerator. With ferrous oxalate 4 parts of citrate of iron and ammonia should be added to each 50 parts of the accelerator used. Filtered from time to time and kept in stoppered bottles, this preparation lasts for many years.

In the development of bromide and chloride papers a very weak solution of hypo-soda is recommended, except when hydroquinone is used, when an increased amount of alkali secures the desired rapidity. The use of common salt is also said to be beneficial in the development of positive bromide papers.

Accidental Points. Lines vary according as they are situated above or below the eye

FIG. 4.



of the observer. To prove this, hold up a piece of glass on which a series of lines have been drawn reaching from the centre, and look through it up a street or along an inclosure. It will be seen that those lines which are at right angles with the base line, fall in with and cover many of the lines so drawn upon the glass; for as they run to a point of sight they will of necessity converge, since the space between will diminish as they recede from a spectator. Let the figure rep-

resent a case with folding doors, placed immediately before the eye. The sides appear to rise and descend to the point of sight, A, also the door B, from its being open at right angles with the base line, while the lines of the door C appear to run to the accidental point D. This point will vary in its situation according as the door is more or less open, which explains what are termed "accidental points."

Acetate. A salt formed by the union of acetic acid with an alkali, earth, or metallic oxide. The majority of acetates are very soluble in water, and by destructive distillation yield either acetate and water or acetone acetic acid. The aqueous solutions of the alkaline acetates turn mouldy, and are decomposed by keeping. Care should therefore be taken to dissolve no more at once than is wanted for immediate use. Nearly all the acetates are formed by direct solution of the hydrate or oxide of the base in the diluted acid; or by double decomposition. They are characterized by the following properties: By emitting fumes of acetic acid when sulphuric acid is added; by changing to a deep red when in contact with sesquisalts of iron; by the white lamella and pearly precipitate they produce with the nitrates of mercury and silver, and by the production of acetone by exposure to a dull-red heat in a close vessel.

Acetate Bath. A favorite toning bath, consisting of acetate of soda, gold, and water, for use with albumen paper. It is said to be preferable to all others for steadiness in manipulation, fineness of grain in the print, and economy of gold. The usual formula gives 1 grain of gold to 8 ounces of water, to which ½ drachm of acetate of soda is added. The use of acetate of soda in this connection was first suggested in 1859.

Acetate of Ammonia. This salt consists of 1 part of ammonia, 1 of acetic acid, and 7 of water. It is generally prepared by saturating acid with carbonate of ammonia. It is used in photography for the preparation of sensitive solutions for glass and for paper proofs. M. Molard applied this substance as an accelerator for negative proofs treated with gallic acid. Its action is to continue the reduction commenced by light, but, as it often goes too far and darkens and spots the proofs, caution is necessary, and the greatest nicety required to produce good results.

Acetate of Iron. There are two acetates of iron, both soluble in water—a protoacetate, the solution of which is colorless, or nearly so, and a red peracetate. The former, which corresponds in composition and properties to the proto-sulphate and proto-nitrate of iron, may be obtained by mixing acetate of lead and sulphate of iron in atomic proportions. For a solution to contain 10 grains to the ounce, 16 grains of sulphate of iron and 21 grains of acetate of lead, each dissolved in 4 drachms of *cold* water, will be required.

Acetate of Lead. This salt is composed of 1 part of oxide of lead, 1 of acetic acid, and 3 of water, and is generally known in commerce by the name of sugar of lead, owing to its sweet taste. It is soluble in 4 parts of water, and may be prepared by boiling carbonate of lead with acetic acid until the acid is saturated, filtering the solution and evaporating until a pellicle forms on the surface. Upon cooling, crystals of acetate of lead are deposited. These are deadly poison. Recommended for the reduction of silver in wash waters, and of nitrate of lead in the combined toning and fixing baths.

Acetate of Lime is composed of 1 part of lime, 1 of acetic acid, and 6 of water. It crystallizes in silky-looking, slender, acicular crystals. It is employed in union with gallic acid to develop the image very rapidly. It seizes upon a part of the oxygen of the protoxide of silver and decomposes the iodide of silver, forming acetate of silver and iodide of lime; one part of acetic acid is destroyed, which quits the oxide of silver to unite with the water and carbonic acid, which combines with the lime, and the reduced silver is precipitated of a black color by gallic acid. This action takes place particularly in parts impressed by light, therefore this salt facilitates the development of the image. Too large a quantity of the salt would develop too energetically and the whole proof be ruined by the action of the gallic acid.

Acetate of Potash, $KC_2H_3O_2$, a very deliquescent salt, very soluble in water and alcohol. Reagent on tartaric acid, which, with it, forms a precipitate of crystalline bitartrate of potash, very difficult of solution, in which it differs from citric acid.

Acetate of Silver. A compound obtained by adding acetic acid to a solution of silver. It is composed of one part of silver to one of acid. From long use the nitrate bath becomes impregnated with this salt, which

interferes with its sensitiveness, and must be removed by the addition of more silver solution, or by aqua ammoniae.

Acetate of Soda, $NaC_2H_3O_2$, colorless crystals, losing the water at 100°, melting at 210°, forming a white fibrous mass. Used in toning-baths as a neutralizer. The crystals serve as a retarder in the hydroquinone developer, and as an accelerator in the collodion negative developer.

Acetic Acid. Composed of 4 parts carbon, 3 parts oxygen, and 2 parts hydrogen. It is found naturally prepared in the sap of many plants, but for general use it is prepared by fermentation. That of commerce is obtained from vinegar, of which there exist four varieties, known as *malt vinegar*, *wine vinegar*, *sugar vinegar*, and *wood vinegar*. The first three are made by the acetous fermentation which converts the alcohol of these solutions into acetic acid by the absorption of oxygen; the last by the destructive distillation of wood in iron retorts. "There are three distinct processes employed for the manufacture of acetic acid, viz: I. *The decomposition of dry acetate by oil of vitriol;* II. *The decomposition of the acetate of copper or lead by distillation;* and III. *The decomposition of the acetate of lead by sulphate of iron or soda in the dry way.* It possesses a powerful odor and acid taste, dissolves camphor and resins, and mixes with alcohol, ether, essential oils, and water. In its pure state it is a corrosive and an acid poison. It unites with the bases, forming salts called acetates. It should be kept in stoppered glass bottles. Acetic acid is used in photography as an ingredient for sensitive compounds for paper processes, for acidifying the nitrate bath for development, and for changing the color of paper photographs to black; a few drops added to the hyposulphite solution being all that is necessary. It is mixed with the nitrate solutions, in various proportions, and combining with the silver forms the *aceto-nitrate of silver*. (See *Glacial Acetic Acid.*)

Aceto-Nitrate. This compound is formed by the combination of acetic and nitric acids with a base. In photography it is used as an accelerator, and in connection with silver, forms the *aceto-nitrate of silver*, which is more readily darkened by the light than the nitrate of silver alone.

Achromatic. Free from color.

Achromatic Mirror Stereoscope. An instrument invented by the Messrs. Beck, of London. The principal feature of this stereoscope is in the application of a mirror in such a position that when the instrument is held facing the light the picture receives reflected rays in addition to the direct ones, and in different directions. This double illumination imparts a proportionate brilliancy to the photographs, and adds greatly to the perfection of the resulting stereoscopic slide.

Achromatism. Freedom from chromatic aberration.

Acid. In common language, any substance possessing sourness or acidity; in chemistry, any electro-negative compound capable of combining with bases to form salts. Most of the liquid acids have a sour taste and redden litmus paper. Acids are variously classed by different writers, into *organic*, *inorganic*, *metallic* and *non-metallic; oxygen acids* and *hydrogen acids*, and acids *destitute of either of these elements;* the names being applied according to the kingdom or nature or class of bodies from which they are derived, or after the element which is supposed to be the acidifying principle. The names of acids end either in *ic* or *ous;* the first being given to those containing the larger portion of the *electro-negative* element, and the last to those containing the smaller quantity. For instance, sulphuric acid contains 1 equivalent of sulphur and 3 equivalents of oxygen, the acidifying principle; sulphurous acid containing 1 equivalent of sulphur and only 2 equivalents of oxygen. When a base forms more than two acid compounds with oxygen, the Greek preposition *hypo* is prefixed to that containing the smaller portion, as *hypo*sulphuric acid, *hypo*-sulphurous acid. The prepositions *per*, *hyper*, and the syllable *oxy* are also prefixed to the names of acids when it is intended to denote an *increase* of oxygen, as *hyper*nitrous acid, *per*chloric acid, *oxy*muriatic acid. *Hydro* is another prefix employed to designate the compounds of *hydrogen;* as *hydro*-chloric acid, *hydro*-fluoric acid, etc. All acids should be kept in glass bottles, having ground glass stoppers, except hydro-fluoric acid, which is destructive to glass and should be kept in lead or platina bottles.

Acid Fixing-Bath. In 1889 Lainer proposed the addition of acid sodium sulphite to the ordinary fixing-bath used for gelatine negatives; the advantages claimed for this

innovation are that the plates are both fixed and *cleared*, and that the fixing-bath remains clear and effective for a longer period. These advantages, however, have been seriously questioned by many workers, and photographers are divided on the matter in practice, some asserting that sulphuration occurs to the deterioration of the negative. Lainer's formula for acid fixing is as follows:

(1) Make up thirty-four ounces of ordinary hypo-soda solution, one ounce of hypo to four ounces of water.

(2) Make solutions of tartaric acid and of sulphite of soda, each of the same strength (1 to 4 parts).

Mix one ounce of the tartaric-acid solution with two and a half ounces of the sulphite solution, and then add the mixture to the thirty-four ounces of hypo solution. (See *Fixing*.)

Acidify. To make a solution or bath acid.

Acidity. Partaking of an acid nature. Impregnated with an acid.

Acidity of Collodion. Photographic collodion frequently becomes acid from various causes, and then does not give the required results. To correct this acidity, dissolve caustic potassa in alcohol, and add a drop or two to the collodion; it will remove all the redness by causing the free iodine to combine with the potassium. Calomel also serves. But if the pyroxylin should be decomposed or rotten, these will not restore the collodion to good working order, and it should be set aside.

Acidity of the Coloring and Fixing-Bath. Hypo coloring baths, or, as they are generally termed, toning-baths, which are in active working order, will usually be found to redden blue litmus paper slowly. The acid bath colors quickly and produces dark tones, but it is apt to turn the white portions of the print yellow, and it always dissolves away the lighter shades more or less, so as to render over-printing necessary.

An alteration in photographic action takes place by neutralizing.

A neutral bath dissolves the lighter shades to a considerably less extent, and it does not interfere with the pureness of the whites, but if the coloring principle is not present in considerable quantity the action is slower. Careful manipulation with the acid bath will produce excellent results and permanent prints, but if the operator prefers the neutral, he can best neutralize the first by the addition of *carbonate of lime*.

Acidity of the Nitrate Bath. The nitrate bath frequently contains free acid caused either by the impurity of the nitrate of silver, or from its containing *free iodine*, and also by working collodion containing free iodine. It can be neutralized by *carbonate of soda*; by the addition of *oxide of silver*; or by hanging a bit of marble in the solution. When the carbonate of soda is used, it is necessary to test for alkalinity, and if discovered, correct by adding one or two drops of glacial acetic acid, or until completely neutralized.

Actinic. So to speak, photo-chemically active. Actinic light acts on a light-sensitive body, when this is exposed to it. On the common bromide of silver gelatine-emulsion films, ultra-violet, violet, indigo, blue and green light acts actinically, while the yellow and red light in this case is designated as non-actinic.

Actinism. The property in the sun's rays which produces chemical changes. Of the three primary colors which compose a sunbeam each is representative of one of the three distinct functions of light: to illuminate, to heat, and to produce chemical changes. The luminous power is chiefly in the yellow rays, the heating power in the red rays, and the chemical power in the blue rays. To the chemical force of light, which is associated with and yet distinct from the illuminative principle, is given the name of actinism. Actinic rays of light, therefore, are those which produce chemical changes or photographic action, varying according to the substance exposed to their action, chiefly the blue, indigo, violet, ultra-violet, and green portions of the spectrum.

Actinolyte. A chemical compound analyzable into its components by light. "I propose its use so as to include chemical synthesis as well as analysis; and in the present state of our knowledge it would be convenient to extend the term to all the substances employed by photographers on which light exerts a marked sensible change, although it may be uncertain how far that change is chemical or mechanical."—*Prof. Wilson.*

Actinolytic. Pertaining to actinism, as actinolytic effect, *i. e.*, photogenic effect. The property of receiving or imparting actinism.

Actinometer. An instrument for measuring and recording the actinic (chemical)

force of light, used in photography to determine the proper exposure in various negative and positive processes. Sometimes erroneously (as in Monckhoven's *Carbon Process*) called Photometer (q. v.). Since the earliest days of photography various forms of actinometers have been devised, details of which cannot be given in this brief notice of the subject.

The actinometers most used at present for gelatine dry plates are Hurter and Driffield's *Actinograph*, Ballard's *Actinometer*, and Watkin's *Exposure Meter*, descriptions of which may be seen in the catalogues of dealers in supplies.

As the chemical action of light varies according to the sensitive surfaces employed in the various processes of photography it follows that no one actinometer can be universally applicable. The use of albumen paper has, however, become so general, that silvered albumen paper forms the essential feature of the majority of actinometers designed for use in photographic printing. The most common of these is the Johnson actinometer, consisting of a small tin box with hinged lid in which a square of glass, painted a standard tint, is placed, with a space of clear glass in the centre. A roll of sensitive albumen paper is placed in this box and drawn as needed, under the lid, and when the piece of paper under the clear glass is colored as deeply as the standard tint, one tint is said to be registered. Having ascertained how many tints of the actinometer any given negative requires in printing, the correct time of exposure is known for all future prints required from the negative in use.

Actinometry. The science of measuring and comparing the varying chemical force or photographic activity of light.

Actino-Polychrome. A name given to natural colored photographs.

Adamantean Process. A method of securing hardness to the printing surface of the etching in half-tone photo-engraving.

Adhesive Substances. The mucilages and other substances used in mounting photographs. Those generally employed are starch, albumen, isinglass, and gum arabic, and later dextrin, which is preferable.

Aerial Perspective. That kind of perspective which teaches to reproduce objects in a picture according to distance and illumination, so as to make them appear true to nature. In photography, it usually means the effect of distance in a view.

Agar-Agar. East Indian alga; of a gelatinous nature, at one time recommended as a substitute for gelatine and albumen in the preparation of emulsions, etc. It is rarely used.

Agent. That which has the power of operating or producing effects. Light, heat, chloride of gold, and hyposulphite of soda are among the agents actively employed in photography.

Aggregation, State of. Manner in which the smallest divisible particles of a body are arranged and combined. All bodies occur either in a solid, liquid, or gaseous state.

Air-Brush. An instrument operated by air pressure, which projects or distributes upon any desired surface liquid or powdered color in fine particles in the form of spray, in any degree of fineness or concentration according to the will of the operator. The first air-brush was invented by L. Walkup, an American, and was designed primarily to replace the pencil in retouching negatives and positives. This instrument has recently been introduced in a more compact form, although operated on the same principle, by Mr. C. L. Burdick, of Chicago. The Burdick brush is about the length and thickness of a lead-pencil. The air-brush is largely used by photographic enlargers and all classes of industrial designers; it has also been applied recently to lay the grained ground requisite in the photo-mechanical processes.

Air-Bubbles, faults often conspicuous by their uninvited presence, when treating films (plates or paper) with liquids, and, if not quickly removed, affecting the beauty of the result unfavorably. They also often form when squeegeeing gelatine prints on glass, metal plates, etc. If they cannot be pressed out, they should be pierced from the back with a very fine needle.

Alabastrine Photographs. Positives on glass treated with the alabastrine solution. The following formula is given as the best—collodion and bath as usual for positives:

Developer.

Iron Salt	5 grains.
Acetic Acid	10 minims.
Water	1 ounce.

After well washing re-develop with a solution of bichloride of mercury; thirty-grain solution of proto-sulphate of iron, twenty-five drops.

Albertype. A photo-collographic process devised by Jos. Albert, of Munich. As this process was the first workable method of collotypy made known, a brief *résumé* will be interesting.

A piece of glass five-eighths of an inch thick is coated with the following solution—in the dark-room:

Water	300 parts.
Albumen	150 "
Gelatine	15 "
Red Chromate of Potash	8 "

When the film is dry it is exposed to light for two hours *through the glass*, backed by a piece of dark cloth, so that the film may harden from the bottom (next the glass) to the surface.

The exposed plate is now coated with the following:

Gelatine	200 parts.
Red Chromate of Potash	100 "
Water	1800 "

When again sufficiently dry the plate is exposed under a negative, washed for fifteen minutes, and dried. Then slightly wet the film, ink with printers' ink in the usual way, and print in a lithographic press, as in lithography. This process gives prints with fine half-tones, but requires considerable care and experience in manipulation, much depending upon the printing.

Album. A neat arrangement for the preservation of photographic pictures. The size must be governed, of course, by the size of the prints.

Fig. 5 shows the arrangement for fastening the separate sheets. *A, B, C, D* is the picture-holder, which is joined to the small cartoon-strip, *a, b, c, d,* by a fold of linen. This strip is provided with two holes, which must exactly correspond in laying the sheets over one another. The binding consists of two strong cartoons, which are bound by a leather back, and in the corresponding places with the two openings they are furnished with a leather fold. By two screw-bolts, which run through all the sheets and the two bindings, by means of the two openings, the whole system is held together. By loosening the two screws the pictures can be taken out and placed together as one wishes. The thread of the screw must not be cut in any farther than necessary, so as not to render the lifting of the leaves too difficult.

Fig. 6, screw-bolts with box; Fig. 7, closed album; Fig. 8, album opened. (For

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

clearness only a few sheets are given in the sketch; in reality, there are fifty to one hundred pieces.)

Albumen. A complex substance existing in many of the solids and fluids of the animal body. It occurs in its purest forms in the white of egg and in the serous or liquid portion of the blood. According to Wurtz, it consists of carbon 52.9, hydrogen 7.2, and nitrogen 15.6. Mülder found traces of sulphur, about 0.05 per cent. It is obtained from whites of eggs by beating them up, diluting with water, and filtering the solution so obtained free from the shreds of membrane with which it is mixed. The fluid is slightly alkaline, and may be neutralized with acetic acid. After evaporation at a very gentle heat, an amorphous, yellowish, transparent substance is obtained, which is soluble in cold water, and in strong nitric and acetic acids.

The most characteristic property of albumen is its power of coagulation. Blood albumen is in almost every respect similar to egg albumen, as also is vegetable albumen.

A. is employed in photography for albumenizing paper (silver printing); in the manufacture of emulsions; as a substratum in various processes; and in the photomechanical processes.

Almost all metallic salts form with A. insoluble compounds called albuminates; the albuminates of the alkalies are, however, all soluble. A. is the best antidote for the salts of mercury and copper (Orfila).

Albumenized. Coated with albumen.

Albumenized Collodion. Collodion coated with albumen. It is used in the so-called Taupenot dry process. The following formula for its preparation is considered the best: Take of albumen 20 ounces. In one-third of this quantity, of distilled water, that is, 6 ounces 5 drachms, dissolve 192 grains of iodide of ammonium. Then add 3¼ drachms of solution of tincture of iodine 12 grains to 1 ounce of alcohol. Pour this iodized water, little by little, into the albumen, beating it with a wooden fork. The albumen having been well frothed is allowed to stand from twelve to fourteen hours.

Take of simple collodion 1 ounce; add iodide of ammonium 2½ grains; iodide of cadmium 2½ grains; solution of proto-iodide of iron 15 drops. Allow it to settle. When about to prepare the glass plates, decant the albumen and collodion. Clean and collodionize the glass in the usual way (see *Albumenized glass*, *Collodionized glass*, and *Dry process*); the collodion having been sensitized in a 40-grain silver bath, cover the collodion with the albumen solution and allow it to dry for twelve or fourteen hours. The plate after this is plunged for fifteen or twenty seconds into a bath made as follows:

Distilled Water	8 ozs., 6 drms.
Dissolve and add Fused Nitrate of Silver . . .	2 " 4 "
Acetic Acid	1 oz., 3 "
Alcohol	30 ozs.

Let it remain at least twelve hours and then filter.

After remaining in the bath the required time, the plate is first washed in alcohol and then in distilled water. Set aside to dry for five or six days before using. Develop with pyrogallic acid and acetic acid, adding a few drops of a 10-grain solution of nitrate of silver.

Albumenized Glass. Glass coated with albumen. To obtain perfect proofs it is necessary that the albumen should be spread perfectly even upon glass. This may be done by placing your glass plate upon a stand having levelling screws attached for the purpose of making it perfectly horizontal. Pour upon it a profusion of the albumen, and then incline the glass slightly in every direction so that the albumen may completely cover the surface; then place a glass funnel in your albumen bottle and set your glass plate in it cornerwise, and drain off all the superfluous mixture until only sufficient to form an infinitely fine coating remains. Dry the edges of the glass with bibulous or tissue paper, and replace it upon the level support to dry, taking care to cover it with a pasteboard box—made for the purpose—that it may be kept free from dust. In this state it is ready for the sensitive mixture.

Albumen Paper. Paper coated with albumen. To prepare the paper, take of

Chloride of Sodium or Ammonium	10 grains.
Distilled Water	1 ounce.

The common table salt is often impure, and therefore, if the pure chloride cannot be obtained, chloride of ammonium (*muriate of ammonia*) may be substituted. Mix any number of ounces according to the above formula and add an equal bulk of the whites of new-laid eggs. Then with a bundle of quills, or a wooden fork, beat the whole into

a perfect froth. As the froth forms, it is to be skimmed off and put into a flat dish to subside.

Pour a portion of the albumen solution into a flat dish to the depth of half an inch. Then, having previously cut the paper to the proper size, take a sheet by the two corners, bend it into a curved form, convexity downward, and lay it upon the albumen, the centre part first touching the liquid, and the corners being lowered gradually. In this way all bubbles of air will be pushed forward and excluded. One side only of the paper is wetted; the other remains dry. Allow the sheet to rest upon the solution for *three minutes*, and then raise it off, and pin up by two corners. If any circular spots, free from albumen, are seen—caused by bubbles of air—replace the sheet for the same length of time as at first.

Albumen Printing Process. The method of impressing photographic pictures on albumenized paper. (See *Printing*.)

Alcohol. Pure highly rectified spirit, obtained from fermented liquors by distillation. It consists of hydrogen, oxygen, and carbon, is extremely light and inflammable; it mixes in all proportions with water, dissolving resins, essential oils, wax, spermaceti, and various other substances. Ordinary alcohol is not pure, containing more or less water, its strength being denoted by the degrees of the hydrometer or alcoholmeter. Absolute alcohol, the strongest sold, contains 2 per cent. of water. To free it perfectly, it is necessary to put in the still with alcohol of 90°, some caustic lime or fused chloride of calcium. Alcohol thus treated has a specific gravity of 793; it then boils at 169° F. Alcohol may be also concentrated by exposing it in ox-bladders, owing to the property which the latter possesses of allowing water to pass through the pores and evaporate out, but giving little or no facility for the vapor of alcohol to escape. Both surfaces of the bladder should be soaked in water, and freed from fat and minute vessels adhering to both the outer and inner surfaces; it should then have two coats of isinglass on the outer and four on the inner surface; the spirit is then poured in, but the bladder not quite filled by it, a portion of air occupying the top; it is then tied tightly at the mouth and hung in a warm place. In this way alcohol may be concentrated in twelve hours for photographic purposes.

Alcohol boils at 176°; curdles milk, coagulates albumen, and separates both starch and gum from their mucilages; it is uncongealable by cold, and with acids forms ethers. Alcohol is extensively used for photographic purposes. Diluted with three or four parts of water it is excellent for mixing with the rottenstone with which the daguerrean plate is first cleaned. The rottenstone is first dusted upon the plate and then a drop or two of alcohol mixed with it, or the cotton is wetted with the alcohol and then applied. It is also used in the manufacture of collodion and to form solutions for photogenic processes upon glass and paper, which will be found treated of under their appropriate heads.

Alcohol, Methylic. CH_3OH. Syn., wood spirit, wood naphtha, pyroxylic spirit. Prepared, together with acetic acid, by the destructive distillation of wood. A brown inflammable liquid, employed in a crude state in the manufacture of methylated spirit.

Alcoholic Collodion. A collodion made with an excess of alcohol; or equal parts of alcohol and ether. (See *Collodion*.)

Alcoholic Solution. Any substance dissolved in alcohol.

Alcoholized Paper. Paper prepared with an alcoholic solution. The photographic paper to which this name has been peculiarly given is thus prepared: Immerse Saxe or any other good paper for four or five minutes in a solution of

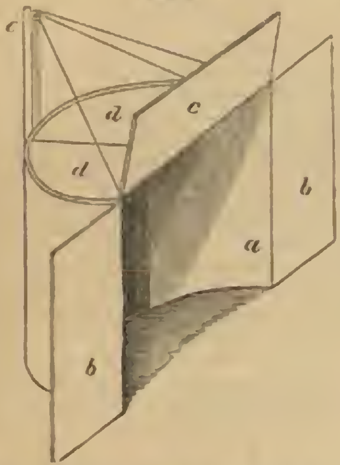
Alcohol from 15° to 20½° . . .	19 ounces.
Sugar of Milk	to saturation.
Iodide of Zinc	155 grains.
Bromide of Zinc	31 "

Hang up to dry. Sensitize with a 5 per cent. solution of aceto-nitrate of silver, adding a 7 per cent. solution of glacial acetic acid.

Alcove Background. This system was designed by Adam Salomon. It consists of a curved background, *a*, about eight feet high and ten feet wide at the curve; that is, the diameter of the circle of which the curve of the background forms half is ten feet, and the radius, of course, five feet. Hinged to each side of the background are movable wings, *b*, about four feet wide, and a canopy, *c*, of a similar character and width is hinged to the top in front. Behind this projecting front canopy is a covering or canopy to the curved part of the back-

ground; this consists of two halves, *d* and *d*, hinged in the centre. Attached to the background at the back is a rod, *e*, terminating in a series of loops or pulleys. Through these pass cords which are attached to the canopies *c* and *d*. The cords are all brought to a position behind *e* at the side of the background, where the operator can readily manipulate them, each cord having a counterpoise attached, so as to maintain the canopy in any position into which it is pulled by the manipulators. The wings and canopy, *b b* and *d c*, are light frames covered with thin, transparent, white muslin, trans-

FIG. 9.



mitting some light, but arresting or breaking up direct rays of sunlight. At each end of the canopy *c* is attached a piece of thin muslin, which we have not figured, as it would have somewhat confused the diagram. It is the same width as the wings, over the top of each of which a piece hangs, to maintain the continuity between the wing-screens and the projecting canopy. The canopies, *d d*, are also light frames covered with thick white calico, transmitting very little light. The background rests on three feet, one at each side and one in the middle; these each project behind about eight inches, to give firmness and steadiness; each foot has a large caster, to permit the whole to be wheeled round easily into any position. The wings are hinged to hang an inch or two from the ground, so as to be easily moved backward and forward. The background is papered.

Aldehyde. This is a product of the oxidation of alcohol or ether. It is prepared by passing the vapor of ether, or of alcohol, through a red-hot tube; or by distilling sulphuric acid six parts, alcohol four parts, water four parts and oxide of manganese six parts. Aldehyde is a colorless liquid, with a suffocating etherial odor, specific gravity 0.79, boils at 72° F., soluble and neutral, but becomes acid on exposure to the air, and unites with bases to form salts; when kept for a long time two new isomeric bodies are formed, *eladehyde* and *metaldehyde*. Aldehyde is similar in constitution to alcoholic sensitives used in the manufacture of collodion, and is a powerful reducing agent.

Alkali. A substance which possesses the property of forming salts with the acids, and for the most part turning the vegetable blues to green, and yellow turmeric paper brown. The principal alkalies are *soda*, *potassa*, *ammonia*, *baryta*, *calcium*, and *magnesium*. The first of these is called the mineral, the second the vegetable, and the third the volatile alkali. Alkalies have, in a greater or less degree, a peculiar acrid taste and great causticity. They are soluble in water, and, when pure, in alcohol, and form salts with the acids. The pure or caustic alkalies should be kept in glass bottles, well secured from air, as they rapidly absorb carbonic acid and become carbonates. The alkalies color blue litmus paper red.

Alkaline Bromides. Compounds of bromine with alkaline bases, such as bromide of potassium and bromide of ammonium.

Alkaline Chlorides. Chlorides having alkalies for their bases. Chlorides of ammonium, potassium, and sodium are examples.

Alkaline Cyanides. Compounds of cyanogen with alkaline bases, as cyanide of potassium.

Alkaline Developers. Reducing agents in solution, mixed with alkali salt (carbonate of potash or soda, caustic soda or potassa) or liquor ammonia. The office of the alkali is to bind the bromide, as it becomes free from the silver during development. If a bromide salt is added, bromide of silver is again formed, thus retarding reduction. The more common alkali developers are: eikonogen, hydroquinone, metol, paramidophenol and pyrogallic acid.

Alkaline Development. A few years after the use of dry (collodion) plates had become known, Mr. Henry T. Anthony, of New York, discovered that fuming these plates with weak ammonia rendered them more sensitive. Acting upon this suggestion Leahy, of Dublin, immersed his plates in a weak solution of ammonia and found that development was thus accelerated. Russell, in 1862, mixed pyro and ammonia in solution, and reported that this combination formed a very energetic developer. This procedure was in due time applied in the development of gelatine dry plates, and alkaline development became general.

The principal action of the alkalies in development is to increase the property of certain developers to absorb oxygen, which facilitates the reducing action. They also cause certain changes to take place in the bromide of silver film, which predispose the silver haloids to dissociation and consequent building up of the image on the plate. The caustic alkalies are more energetic in action than the carbonated alkalies, and the former are, therefore, more likely to cause fogging when used in large doses than the latter. Duchochois advises the addition to the developer of one-half part potassium bromide per cent. when large doses of the alkalies are needful in development.

Alkaline Gold Toning Process. Certain requirements are necessary in order to insure perfect results by this process. The paper must be the best, well albumenized with fresh-laid eggs, salted with fifteen grains to the ounce. The silvering solution must be kept up to the strength of sixty grains to the ounce. Several different formulæ for alkaline toning baths have been proposed, but the following have been most generally adopted:

Chloride of Gold	1 grain.
Phosphate of Soda	18 grains.
Distilled Water	q. s.

The chloride of gold and phosphate should be kept in separate solutions and mixed diluted with water sufficient to float the prints as required. The only effect in using a large quantity of water is to retard the toning, which is often of advantage. From five to ten minutes are required, the print being allowed to assume a deeper color than is desired, as some is lost in the fixing bath, which is the ordinary hyposulphite of soda solution.

The Le Gray toning bath is thus composed:

Chloride of Gold	1 grain.
Chloride of Lime	1 "
Chloride of Sodium	1 "
Distilled Water	4 ounces.

The treatment of the print by this bath is the same as the first; but, as it possesses powerful bleaching properties, it is necessary that the prints be considerably over-printed.

M. l'Abbé Laborde's process has two advantages over the first two here mentioned, in giving a peculiarly rich purple tint, and its capability of being used more than once, all other alkaline baths being useless after one application:

Chloride of Gold	15 grains.
Acetate of Soda	7½ drachms.
Water	35 ounces.

The solution becomes colorless by degrees, and after standing twenty-four hours is ready for use. On removing the positive from the printing frame, it is thoroughly washed in fresh water; it is then immersed in the gold bath from twenty-five to thirty seconds when the bath is first used—as it gets old longer time is required, which must be determined by practice—too short a time gives a disagreeable red hue after fixing; if too long, a cold blue tint. When toned to the desired tint, wash repeatedly and fix in a bath containing 4 ounces hyposulphite of soda to 1 pint of water. (See *Toning*.)

Alkaline Hyposulphites. Compounds of hyposulphurous acid with alkaline bases, as hyposulphite of soda, etc.

Alkaline Iodides. The compounds of iodine with alkalies, as iodide of potassium, ammonium, etc.

Alkaline Nitrate of Silver. A compound of nitrate of silver with an alkali. The ammonia-nitrate of silver, employed in the photographic printing processes, is a familiar example.

Allotropic. The unusual modification of a body appearing in two or more forms, of different properties but chemically identical (for instance, red and yellow phosphorus, liquid and coagulated albumen, oxygen and ozone, etc.). Some bodies become allotropic by light, others at a certain temperature.

Allyl. Recent experiments by Colonel Waterhouse have demonstrated that it is possible to obtain direct positives on glass in the camera by the addition to the devel-

oper of a small quantity of *sulpho-carbamide of allyl*. The sulpho-carbamide of allyl is prepared by mixing the essential oil of mustard with six times its volume of liquor ammonia. The crystallized product obtained by evaporation of this product is purified and made up in the form of a concentrated solution, of which 8 to 10 drops are added to the usual developing bath. An account of the method of preparation and application may be found in *Mosaics*, 1894.

Alpha Paper. A certain kind of gelatino-chloride of silver paper for positive prints by development.

Alum. This well-known salt is prepared by roasting and lixiviating certain clays, containing iron pyrites, and adding to the lees a quantity of sulphate of potassa. It is obtained in Italy from alum-stone. It is also found in volcanic countries, produced by the action of sulphurous vapors on rocks containing feldspar. It has a sweetish astringent taste, is soluble in 5 parts of water at 60°, and crystallizes in octohedrons. It is occasionally used in photography for washing positive prints after fixing for the purpose of removing every trace of the hyposulphite of soda. The pictures are washed in a dilute solution of alum before hanging up to dry. It is also used as a film on wood for the reception of the photographic image, and an advantage is said to be gained by adding a trace to the printing bath. Alum serves to harden and clear gelatine films, both of negatives and of papers.

Alum, Chrome. A double salt employed in hardening and clearing the film of gelatine plate negatives and in other manipulations as a substitute for common alum.

Alum Cells. A trough of clear alum solution placed in the ordinary stage of the optical lantern to absorb the heat evolved by the lime or electric light, when delicate microscopic specimens are being projected, to which the heat would prove destructive.

Aluminium. A metal which promises to be of great utility in photography, occurring abundantly in feldspar, clay, slate, and many similar substances. It is white in color, malleable, light in weight, and not liable to tarnish. Used in photography for all purposes for which brass is suitable, such as for camera bindings, lens mounts, tripod heads, etc. Powdered and leaf aluminium, used as a flash-light compound, give an intensely bright light without the disagreeable fumes incidental to the burning of magnesium. The subjoined formula is said to give excellent results:

Aluminium Powder	24 grains.
Chlorate of Potassium	60 "
Sugar	6 "

Aluminium chloride may be used in the development of negatives with amidol, and in the toning or developing of gelatino-chloride prints as a substitute for alum, having a hardening effect upon the gelatine film.

J. R. Clemons recommends the use of aluminium chloride in addition to the gold salt for toning plain paper and albumen prints, giving the following formula:

Water	12 ounces.
Aluminium Chloride	20 grains.

Make this solution decidedly alkaline by adding 85 grains of bicarbonate of sodium, and filter carefully. At the time of toning add 1 grain of gold chloride to the bath for each sheet of paper to be toned. Toning is accomplished in from eight to ten minutes. This bath is said to enhance the beauty of the prints, giving brilliancy, depth, and detail of light and shadow.

On account of its porosity and its peculiar property of absorbing and retaining transferred images, aluminium is recommended as a substitute for lithographic stone in the lithographic processes. Its many advantages for such work, on account of cheapness, lightness, etc., can be readily understood. Lithographic printing from aluminium sheets is said to be of such fine quality and grain that they can be used for printing on bond and other high-grade papers. The flexibility of aluminium renders it available, also, for cylinder printing, another important advantage in lithographic work. In France aluminium is used in thin sheets for visiting cards, photographic plaques, and as a base for carbon or gelatino-chloride transparencies; if covered with black varnish, it may be used in the production of ferrotypes. The investigation of aluminium is yet in its infancy, and before many years have passed it is expected that its usefulness will be still further increased.

Amadine. (*Amidon.*) A substance found in starch paste that has been long exposed to the atmosphere, and also formed immediately by the action of hot water. Its properties are intermediate between those of starch and gum.

Amalgam. A mixture of quicksilver with metals. As amalgams repel fatty transfer inks, they find application in mechanical printing processes.

Amalgamate. To compound or mix one substance with another.

Amber. A fossil resin, occurring as a hard brittle substance, yellowish in color, generally more or less translucent; for photographic purposes amber may be purified by boiling in strong lime for an hour, then washed well, heated in a closed vessel to 150° C., and finely powdered with broken glass. Employed to make cold varnish, being dissolved for that purpose in chloroform or benzole.

Amber Varnish. Amber dissolved in chloroform or benzole. The amber is first pulverized, and after being placed in a close vessel, with a small hole in the lid, is heated gradually up to 212° F. A quantity of white vapor becomes disengaged, which is allowed to pass off, and the amber gradually softens, melts, and bubbles, when the vessel is to be removed from the fire and the mass allowed to cool. Amber thus modified is extremely soluble in benzole and chloroform, and is to be dissolved in the proportion of from 40 to 50 grains to the fluidounce. With benzole a brownish varnish is obtained, but which produces a film on the negative but slightly colored and drying in a few minutes; it is then very brilliant, so much so that it is frequently difficult to distinguish the varnished side from the plain glass, and what is also valuable, it does not soften under the action of the sun's rays. Chloroform may be used as a solvent, but it is more costly, and the varnish produced is much more brittle and liable to injury by rapid changes of temperature.

Ambrotype. The name given by Mr. James A. Cutting to the positive photograph on glass, put up with two glasses and hermetically sealed with balsam of fir. Now applied in general to all styles of positives on glass.

Ambrotype Process. Any of the positive processes on glass giving good results may be used. The following process is recommended as superior: Select glass free from blemishes and clean it well with a mixture of putty-powder in Irish whiskey, ½ ounce of the former to 1 ounce of the latter.

The manipulations in this process are the same as for negatives on glass.

Collodion.

Plain	1 ounce.
Iodide of Ammonium	2 grains.
Iodide of Cadmium	½ to 1 grain.
Bromide of Cadmium	1½ grains.
Saturated solution of pure Chloride of Sodium	3 to 4 drops.

Developer.

Boiling water	20 ounces.
Protosulphate of Iron	1 ounce.
Nitric Acid	1 drachm.

Nitrate Bath.

Water	1 ounce.
Nitrate of Silver	40 grains.
Iodide of Potassium	4 "

Add dilute nitric acid (6 parts of water to 1 of acid), drop by drop, between each trial until the whites are pure and the blacks of a pleasing brilliant lustre.

Varnish.

Methylated Alcohol	10 ounces.
Gum Sandarac	2 "
White Shellac	½ ounce.
Gum Mastic	1 "
Oil of Lavender	1 drachm.

The last to be added after the others are dissolved.

Amidol. $C_6H_3(NH_2)_2OH$. A developing agent—one of the diamidophenol series introduced by Hauff, of Fleurbach, late in 1891. A. is a white powder, easily soluble in water. Mixed with neutral sulphite of soda it forms a very energetic developer without the addition of other alkalies. A. in solution is colorless, with an acid reaction; in time it acquires a faint red tint, and gradually loses in activity. The addition of neutral sulphite of soda to a solution of A. gives a limpid liquid which is colorless, and forms an excellent developer for gelatine-bromide plates, transparencies, bromide, and emulsion papers generally. As a developer for gelatine-bromide plates A. has considerable energy, and acts more rapidly than pyro and soda. In development the image gains rapidly in intensity, with rich gradation of tones. A. may be used repeatedly, and does not fog or cause the plate to fill. A good formula for ordinary use is:

Amidol	80 grains.
Sulphite of Soda crystals	800 "
Water	40 ounces.

Over-exposure is controlled by the addition of a few drops of bromide of potassium (10 per cent. solution). Under-exposure is hardly noticeable when A. is used, except that more time is required in development.

The addition of a small quantity of citric acid to the developer has been recommended. A. stains the fingers, so that carefulness in handling is advisable. According to Waterhouse, if an electric current is passed for a short time through A. in solution, the solution will keep clear for a longer time, and does not so readily lose its developing power.

Ammonia. An alkali which is gaseous in its uncombined state and composed of three equivalents of hydrogen and one of nitrogen. It is often called *volatile alkali*. It possesses great pungency and powerful alkaline properties. Water readily absorbs about five hundred times its volume, and in this state forms strong liquid ammonia, which, when much more diluted, is popularly known as spirits of hartshorn. As usually met with in the form of a crystalline whitish mass, commonly called smelling salts, it is combined with carbonic acid and water, forming a sesqui-carbonate of this base. Ammonia is easily recognized by its pungent odor, changing vegetable blues green, and by producing dense white fumes when brought in contact with those of muriatic acid. Ammonia enters largely into the photographic processes. In the daguerrean art it is exceedingly useful—in a diluted state (say one part liquid ammonia to eighteen of water)—for cleaning the plate. Various solutions of ammonia in combination with salts of iron, silver, etc., are employed for paper and glass photographs. Added to the hyposulphite of soda in fixing it gives fine bistre tints to the photograph, and very pure whites. It should be added to the hyposulphite of soda solution in the proportion of one fluid ounce to one quart of the solution. The employment of ammonia in the preliminary preparation of the paper gives celerity to the formation of the image, since it hastens the metallic reduction of the silver by disengaging hydrogen occasioned by its decomposition. Unfortunately, this effect is a little too violent, always causing spots throughout the proof, which, however, may be avoided by using equal portions of common salt and ammonia. This body must also be employed with the greatest care, for it forms explosive bodies with silver, gold, iodine, and chlorine. Fulminating silver is a black powder produced by the combination of ammonia with oxide of silver. Caustic potassa added to a solution of the salt of silver in ammonia occasions its formation. Fulminating gold is produced by pouring ammonia into a solution of chloride of gold. The precipitate is of a yellowish or brown color. Iodide of nitrogen is produced by adding ammonia to a solution of iodine in chlorine and hydrochloric acid. It is formed with iodide of potassium in certain cases of triple decomposition. Chloride of nitrogen is formed by passing chlorine through a solution of hypochlorate of ammonia, or any other ammoniacal salt. The liquid becomes yellow, and forms oleaginous drops, which fall to the bottom, and which are the chloride of nitrogen. All these products detonate with violence at the least blow. Those who have not a profound knowledge of chemistry will do well not to handle ammonia, except with the greatest care. Ammonia completely dissolves chloride of silver, and may therefore be successfully employed for fixing definitely by washing the proof in several waters.—*Le Gray*.

Ammonia-Alum. $(NH_4)Al(SO_4)_2+12H_2O$. Sold as alum; the same as potash-alum; it differs from the latter in that it gives off ammonia when warmed with caustic soda. Soluble in seven volumes of cold water. Serves to harden gelatine.

Ammonio-Citrate of Iron. A combination of citric acid and ammonia with iron; obtained by dissolving pure iron filings in citrate of ammonia. When the filings are reduced one-half, add a little water, filter, and evaporate to dryness. Papers washed with this compound in a certain state are of great sensibility, and give pictures of great depth and sharpness, but they often spontaneously darken on exposure and become eventually obliterated. (See *Cyanotype and Chrysotype.*)

Ammonio-Ferric Oxalate. Ammonio-oxalate of iron, $Fe_2(NH_4)_2(C_2O_4)_4$, green crystals, soluble in water, becoming more or less oxidized and transformed into the ferrous salt by light. Used in the preparation of papers in the platinum and blue processes.

Ammonio-Nitrate of Silver. A compound consisting of ammonia, silver, and nitric acid. Employed as a sensitive wash for paper in connection with the photographic processes. The solution is made by dissolving one part of nitrate of silver in sixteen of distilled water, and gradually adding strong liquid ammonia until the precipitate first produced is again nearly dissolved; filter. Add ten drops nitric acid. The nitric acid

prevents spotting. This solution is applied to plain paper—previously stretched on a board a little smaller than itself—with a brush, evenly, smoothly, and thoroughly. (See *Silvering the Paper.*)

Ammonio-Nitrate Paper. Paper prepared for photographic purposes with any of the nitrates of ammonia.

Ammonio-Tartrate of Iron. It is composed of 1 part tartaric acid, 3 parts iron filings, digested for two or three days in a sufficient quantity of hot water to barely cover the mixture, frequently stirring it and adding liquor of ammonia; dilute with water, decant, wash the undissolved portion of iron, filter the mixed liquors, and evaporate to dryness. This substance is used in connection with cyanogen and others for the production of photographs. (See *Cyanotype*, *Chrysotype*, and *Amphitype.*)

Ammonium Sulphocyanide. An agent used in toning solutions for gelatino-chloride printing papers, and employed in some cases for fixing, instead of hyposulphite of soda. It does not give enough advantage to warrant its extra cost. It is deliquescent and is soluble in alcohol.

Amorphous. A body which, even in its smallest particles, shows no crystalline form or texture.

Amphi-Positive. A picture produced by a peculiar process discovered by M. Sabatier. (See *Sabatier's Amphi-positive Process.*)

Amphitype. A process in which the light forms a positive and a negative from one and the same picture. Paper is treated with a solution of tartrate of iron or peroxide of mercury, then with a solution of ammonio-citrate of iron in excess, and then exposed in the camera. A negative is obtained, which gradually fades out in the dark, but reappears as a black positive if placed into a solution of nitrate of mercury and afterward treated with a hot iron.

Amyl Acetate. $C_2H_3O_2 + C_5H_{11}$. A colorless oily liquid of agreeable apple-like smell. A solvent of gun-cotton; also used in the place of oil in the normal lamps proposed by the International Congress.

Amyl-Acetate Lamp. At the International Photographic Congress, held at Paris in 1889, the amyl-acetate lamp was adopted as a practical standard of light in photography, to determine the light-sensitiveness of photographic preparations. The dimensions of this lamp are given as follows: Internal diameter of wick-holder, 5 mm.; height of flame, 25 mm.; distance of screen from the axis of flame, 10 mm. The screen consists of thin metal, and is pierced with an aperture 4 mm. high and at least 30 mm. broad. It is fixed to the wick-holder by means of a clip, and is placed at such a height that the aperture is about 10 mm. above the top of the wick-holder. For the purpose of testing sensitive preparations with this lamp, the amount of light falling vertically upon a surface placed at 1 m. is called a meter-candle. The amount of light necessary to produce visible action upon a gelatino-bromide plate is thus attainable in definite figures. An interesting table of comparisons obtained with this lamp was given by Dr. J. M. Eder in *Mosaics*, 1891, to which paper the reader is referred.

Analysis. Disintegration of chemical combinations for the purpose of ascertaining their components (qualitative analysis), and their relative proportions (quantitative analysis).

Anascope. A focussing glass through which the picture on the ground-glass is seen, not reversed but true to nature.

Anastigmat. A wide-angle double-objective, but unsymmetrically constructed (introduced by Carl Zeiss). Its front lens is flat, considerably smaller than the very convex back lens, and perfectly free from astigmatic aberration of the slanting rays, yet leaving a large picture-field perfectly flat, thus giving extraordinary uniformity of sharpness over a large field even with a comparatively large opening. The lenses are of silicate glass.

Anatomical Photography. The application of photography to the purposes of study in anatomy and surgery. It is extensively pursued in hospitals, and has been applied to almost all kinds of cases with great effect.

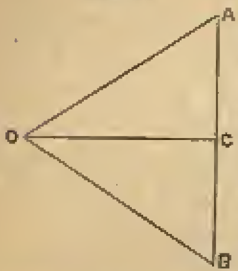
Angle of Field. Width of angle; the angle at which the round picture of the object to be photographed, projected by the objective upon the ground-glass, appears as seen from the optical centre of the lens. Of this picture only the centre portion is sharp, or fit for use, and is called "angle of view." It becomes extended as the objective is stopped down. The angle of field is always greater than the angle of view.

Angle of Incidence. The angle which a ray of light, falling upon a plane, forms with the perpendicular of that plane. The angle

of incidence and the angle of reflection are always equal.

Angle of View. Having found the focus of a lens (which see) the included angle may be determined as follows: Let A B be the diameter of the circle of light given by the lens, which, of course, is easily determined by measurement, and C D the equivalent focus as found; we want the angle A D B. We have A C — D C tan., A D C tan., A D C — $\frac{AC}{CD}$, from the angle, A D B — 2A D C, is easily computed by logarithms.

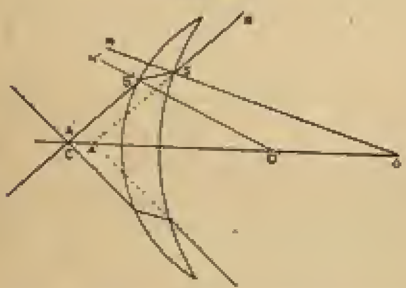
Fig. 10.



The law which fixes the focal length of a meniscus objective is different from that in the case of the combination. In the meniscus *the apex of the emitted cone is coincident with the optical centre*, and from that optical centre, not the actual centre, the focal length must be measured.

In Fig. 11 let O O′ be the centre of curvature of the faces of the meniscus lens, exposed, of course, with its concave surface toward the light. Let a ray of light, R, be

Fig. 11.



incident upon the first surface at S at such an angle that it will, after refraction, pass through the optical centre C, which in the case of a meniscus presented with its concave surface to the object, as usual, is always outside of the lens on the convex side. It will at S be deflected toward the normal, O N, and reach the second surface at S′, where it will be deflected away from the normal, O′ N′, of the exterior curve, and will pass through the centre C. As there is no second lens, it will suffer no further deflection, and therefore the optical centre is in this case, also, the apex of the cone of emitted rays. If the ray R S be produced, it will cut the axis at a point, A, which is the apex of the cone of entering rays. The distance from the point C (and not from the actual centre of the lens) to the focussing-screen will be the equivalent focal length.

Angular Aperture. The diameter of a lens taken in connection with its focal length. Thus we may have lenses, single or compound, of various sizes, and all of the same angular aperture; and, conversely, we may have several lenses of the one actual aperture or diameter, but of various angular apertures (provided their foci differ). It is important to photographers to have a clear conception of angular aperture, as with it varies the intensity of the chemical as well as visual images, this intensity being as the square of the angular aperture.

Anhydrous. Perfectly dry; destitute of water.

Aniline. $C_6H_5(NH_2)$. Phenylamine, amido-benzene. A coal-tar derivative, and the source of many dyes used in photography and in the manufacture of cyanine. When perfectly pure aniline is a colorless liquid, but as generally obtainable is of a brown color, and is very poisonous.

In 1890 Dr. R. E. Liesegang suggested the use of varnish in which a little of any red or green aniline dye had been dissolved for use as a means of intensifying negatives. It is used for coloring positives for "moonlight effects."

Aniline Process. This process, invented by Willis, of Birmingham, is useful for the reproduction of line subjects; it is based on the property of the bichromates of forming, with aniline salts, dark-colored precipitates.

Suitable sized paper is coated with

Potassium bichromate	30 grains.
Phosphoric acid (diluted)	1 drachm.
Water	1 fluidounce.

Float for one minute and dry quickly in a warm room. When dry the print can be exposed under a drawing or transparency until all the details are visible. Development is effected by means of the vapors of

aniline dissolved in benzole or alcohol, sprinkled on blotting-paper, and placed in a shallow box, to the lid of which the print to be developed is fixed. When developed the prints should be washed, and then immersed in acidulated water (1 part sulphuric acid to 100 parts water), and again washed. Aniline prints are fairly permanent, and the process is valuable because of its simplicity and rapidity.

Endemann and Gottlieb also patented similar methods of utilizing aniline for printing purposes, but the processes are seldom used. Variation of tones is obtainable by the addition of diluted gallic acid or ammonia to the last washings.

Animal Charcoal. A common article of commerce, known as *ivory black*. It may be prepared by burning ivory or bone shavings in a close crucible. It is employed in photography to decolorize the aceto-nitrate of silver which has served with albumen.

Annotto. A valuable coloring matter, from the pellicles of the reeds of the *Bixa orellana*. Dissolves in alcohol, ether, volatile and fixed oils, to each of which it imparts a beautiful orange color; very soluble in alkaline dyes, which darken it, and in strong sulphuric acid, which turns it blue. The best annotto is known as roll annotto.

Anthotype. A photographic process discovered by Sir John Herschel, and founded upon the sensibility of the expressed juice of flowers. Certain precautions are necessary in extracting the coloring matter of flowers. The petals of fresh flowers are carefully selected and crushed to a pulp in a marble mortar, either alone or with the addition of a little alcohol, and the juice expressed by squeezing the pulp in a clean linen or cotton cloth. It is then to be spread upon paper with a flat brush, and dried in the air without artificial heat. If alcohol be not added, the application on paper must be performed immediately, as the air (even in a few minutes) irrecoverably changes or destroys their color. If alcohol be present this change is much retarded, and in some cases is entirely prevented. Most flowers give out their coloring matter to alcohol or water. Some, however, refuse to do so, and require the addition of alkalies, others of acid, etc. Alcohol has, however, been found to enfeeble, and in many cases to discharge altogether these colors; but they are, in most cases, restored upon drying, when spread over paper. Papers tinged with vegetable colors must always be kept in the dark, and perfectly dry. The color of a flower is by no means always or usually that which its expressed juice imparts to white paper. Sir John Herschel attributes these changes to the escape of carbonic acid in some cases; to a chemical alteration depending upon the absorption of oxygen in others, and again in others, especially where the expressed juice coagulates on standing, to a loss of vitality or disorganization of the molecules. To secure an evenness of tint on paper, the following manipulation is recommended: The paper should be moistened on the back by sponging and blotting off. It should then be pinned on a board, the moist side downward, so that two of its edges (suppose the right hand and lower ones) shall project a little beyond those of the board. The board then being inclined twenty or thirty degrees to the horizon, the alcoholic tincture (mixed with a very little water, if the petals themselves be not very juicy) is to be applied with a brush in strokes from left to right, taking care *not to go* over the edges which rest on the board, but to pass clearly over those that project, and observing also to carry the tint from below upward by quick, sweeping strokes, leaving no dry spaces between them, but keeping up a continuity of wet spaces. When all is wet, cross them by another set of strokes from above downward, so managing the brush as to leave no floating liquid on the paper. It must then be dried as quickly as possible, avoiding such heat as may injure the tint.

Anthracotypy. A process of reproduction, especially adaptable to the copying of subjects in line on thin (transparent) paper, first described by Dr. Sobacchi. The process is based upon the property of an image obtained on a bichromated gelatine film to swell up and become sticky in warm water, in those parts not affected by light, whereby those parts are adapted to receive and hold powdered colors. Anthracotypy is described at length in Lietze's *Heliographic Processes*.

Antimony. A metal found in a free state associated with arsenic, silver, and nickel; of a bluish-white color, very brittle. Antimony sulphide is employed to make flash-light mixtures, and is a dangerous substance to handle. Sulpho-antimoniate of sodium, usually known as Schlippe's salt, is used for intensifying collodion negatives.

Antiplanat. A non-symmetric objective,

constructed by Steinheil, with front lens of positive and back lens of negative focus. The latter is of unusual thickness, in order to correct the aberrations of the front combination. There are two kinds of antiplanat, one for portraits, one for groups, landscapes, enlargements, etc. The antiplanat combines all the other necessary good qualities, with the extra advantage of less astigmation.

Aperture. A term applied to a lens denoting the actual portion which permits the rays of light to pass through, *i.e.*, that portion which is actually utilized to impress the image upon the plate. It is incorrect to suppose that the diameter of the lens, or of the diaphragm used, constitutes the working aperture of a lens. Abney gives the subjoined method of ascertaining the available aperture:

"A distant object is focussed in the camera so that the ground-glass may be at the equivalent focus of the lens; this screen is then removed and replaced by a glass, over which is pasted opaque paper. A candle is then brought near the screen, in the centre of which a small hole has been punctured. The diameter of the disk of light seen upon the front lens, coming through the orifice in the screen, represents the available aperture of the lens with the diaphragm used for the experiment."

Aphengescope. An instrument used for projecting images of opaque objects upon a screen; sometimes called an opaque lantern.

Aplanatic. The defect of spherical aberration divides photographic objectives into two classes. Some, when used with open aperture, give a sharp image over a restricted focal plane; others, used with open aperture, give only a confused general image. Lenses free from spherical aberration are called aplanatic, the spherical aberration having been corrected by the arrangement of the lenses which form them. An aplanatic lens is, therefore, a lens free from spherical aberration, which will give a sharp image with the open aperture. By the use of smaller diaphragms the naturally small area of sharp definition given by such a lens may be extended. Latterly, the term aplanatic has been used to include also freedom from chromatic aberration.

Aplanatic Lens. A double objective, free from spherical aberration and from distortion. It gives pictures sharp in the middle, even without diaphragming, and with it, only the edges of the picture, not the middle, gain greater sharpness. Aplanats are, according to their construction, divided into portrait, group, landscape, and wide-angle aplanats.

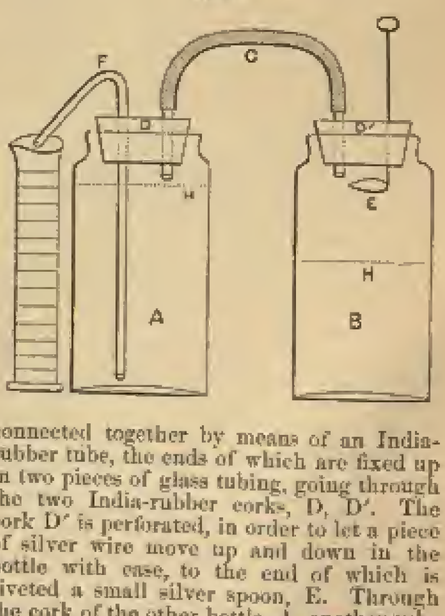
Apochromat. A type of lens-construction (by Carl Zeiss) entirely free from chromatic aberration. The objective (triplet) consists of two single crown-glass concavo-convex lenses (meniscus), with a triple cemented correcting lens of smaller diameter between. This central lens effects the chromatic and spherical correction of the objective; it is made of light borate flint glass.

Apparatus. A term applied without distinction to the implements used in photographic manipulation. Each article is described under its appropriate head in this work.

Apparatus for Cleansing Silver Solution. Devised by Prof. E. Stebbing, and described as follows:

A and B are two bottles, containing about a pint of water each; these two bottles are

Fig. 12.



connected together by means of an India-rubber tube, the ends of which are fixed up in two pieces of glass tubing, going through the two India-rubber corks, D, D'. The cork D' is perforated, in order to let a piece of silver wire move up and down in the bottle with ease, to the end of which is riveted a small silver spoon, E. Through the cork of the other bottle, A, another tube is passed; this tube descends to the bottom, and is curved at its top; see F. In order to

set this apparatus at work, fill the two bottles with water up to the dotted lines, H H. Take 120 minims of a new stock silver solution containing a known quantity of acetic acid, pour it into the bottle, B, then take a few grains of bicarbonate of soda, roll it in a piece of paper, and place it in the spoon, E; now push the corks firmly into the necks of the bottles, then put a graduated vase under the point of curved tube, F. Now, if the silver rod be pushed down into the liquid the paper will burst, and an emission of carbonic acid gas will take place; this will flow along tube C, and press upon the surface of the water in bottle A. The water will then begin to rise and flow out of the curved tube, F. When this ceases the bottle B must be slightly shaken until no more water will flow out. The exact quantity of this must be written down. The contents of the bottle B must be thrown into the silver-waste tray, the bottle well rinsed, and filled again with water up to the dotted lines. The same with bottle A. Now, take exactly 120 minims of the silver solution which has been boiled, and operate in the same manner. If only half the quantity of water that was driven out by the first operation be obtained, it is a proof that the solution lost half its acetic acid by evaporation. The quantity necessary to bring it up to its proper standard can be easily calculated and added.

Aqua-Ammonia. An aqueous solution of a volatile gas. Ammoniacal gas contains 1 atom of nitrogen combined with 3 of hydrogen. Ammoniacal gas is largely soluble in water, and possesses alkaline properties. It differs, however, from the other alkalies in one important particular—it is volatile; hence the original color of turmeric paper affected by ammonia is restored by the application of heat. Aqua-ammonia absorbs *carbonic acid* from the air, and is converted into *carbonate of ammonia;* it should be, therefore, kept in glass-stoppered bottles. It also contains *chloride of ammonium*, detected on the application of a solution of nitrate of silver acidified with nitric acid.

Aqua Regia. Nitro-muriatic acid. So named from its being the only solvent of gold. It is made by mixing 1 part of nitric with 2 parts muriatic (hydrochloric) acid, and 3 parts water. Used photographically in the manufacture of *chloride of gold* and in bromide of silver collodion emulsion to prevent fog.

Aquatint. The manner of coloring; also the graining of metal plates for process work by dusting a resin, and partly melting it, thus serving as an etching ground.

Aqueous. Watery; partaking of the nature of water; abounding in water.

Aqueous Solution. Any substance dissolved in water.

Architectural Photography. This is a branch of photographic work which demands considerable skill and patience in the photographer, and an extensive outfit in the way of apparatus, in order to gain the most effective results.

Apparatus. A good, roomy-topped tripod capable of varied adjustment; a view camera, square in form with reversible back, front and back swing movement, and a reliable spirit level. Rectilinear lenses, of long and short focus, and a reasonably wide angled objective are essential; for 5x7 plates a lens of 7 inches focus will be found most useful.

The point of view is an important matter; if an extended view from the street, or from a neighboring window can be secured, good results may be expected, with pleasing effects of perspective. A careful study of the lines formed by this or that view of a building will insure harmony in the photograph, which is desirable. If it is impossible to get far enough away from the subject, a wide-angle lens should be employed, but distortion must be looked for, and corrected as far as possible.

Lighting. As a rule, strong sunlight, proceeding from one or another side of a building, is best suited to architectural work, giving shadow and relief.

Exposure and development of such subjects require care and patience, and must necessarily vary with each picture. Over-exposure will give flat negatives, lacking in density and contrast, while under-exposure gives harsh black and white effects. The color of the building, season, and time of day require consideration before exposure. Development should proceed gradually, density and vigor being first looked after, when detail may be secured by proper addition of alkali. Eikonogen and hydroquinone offer many advantages for such work. Printing may be suitably done on albumen, plain silver paper, or bromide, this latter being specially adapted for such work.

Argentine. Resembling silver; pertaining to silver, or sounding like it. A silicious

variety of carbonate of lime, having a silvery white, pearly lustre, and a varying or curved lamellar structure.—*Webster.* In *photography* it is used in the sense of the first definition.

Argentine Compounds. In *photography*, compounds of substances with silver.

Argentometer. An instrument for measuring the strength of silver solutions.

Argentotype Paper. A paper introduced by Dr. Ad. Hesekiel; light-sensitive, and prepared with iron and silver salts for prints from negatives. It prints very quickly, furnishing brown-black, platinum-like pictures with matt surface.

Aristogen. A concentrated hydroquinone developer, by Dr. Ed. Liesegang, for developing partly printed pictures on Aristo paper; is mixed, before using, with 12 times its bulk of water. With greater dilution the prints become softer from hard negatives.

Aristotype. This name was first applied to a gelatino-chloride printing paper, introduced in Europe by Dr. Liesegang. In this country, however, the name is given indiscriminately to almost all the newer printing-out chloride papers, whether gelatine, collodion, or celloidine enters into the emulsion.

Aristotype Paper. A paper coated with gelatino-chloride of silver for the printing-out process. It renders strong prints from even, flat negatives, and is easy to work. Both glossy and matt prints can be obtained with it, but the high gloss renders the most detail.

Arrangement. The arrangement of persons or objects to be photographed, as regards the motive of the picture, as also the distribution of the light according to art rules.

Arrowroot Paper. Pure photographic paper coated with a thin film of arrowroot, which film closes the pores of the paper and gives a fine surface texture suitable for printing by photographic methods. For the preparation of arrowroot paper, Vogel recommends:

Water	100 parts.
Chloride of Sodium	2 "
Arrowroot	3½ "

For sensitizing, Liesegang advises:

Nitrate of Silver	1 part.
Distilled Water	12 parts.

The paper is floated for one-half or one minute, and when dry again treated with

Citric Acid	1 part.
Alcohol	48 parts.

When dry it is preserved in the dark. After printing, arrowroot paper may be treated similarly to albumenized paper, but the toning and fixing solutions should only be of half the strength usually employed. This paper lends itself admirably to toning with platinum or aluminium chloride, giving matt-surface prints of great beauty.

Arseniate. A salt formed by arsenic acid combined with any base.

Arseniate of Ammonia. A compound of arsenic and ammonia. To prepare it, take a strong solution of arsenic acid and saturate it with the liquor of sesqui-carbonate of ammonia, and then evaporate and crystallize.

Arsenic. A metal of a steel-gray color and brilliant lustre, and quite brittle. It forms alloys with most of the metals.

Arsenic Acid. An acid compound of two equivalents of arsenic and five of oxygen.

Arsenious Acid. An acid composed of two equivalents of arsenic and three of oxygen.

Arsenite. A salt formed by arsenious acid with a base.

Artificial Ivory. Artificial ivory applicable to photography is the invention of Mr. Mayal, of London. Grind *sulphate of baryta* with *albumen*, until thoroughly mixed, very fine, and it loses its tacky nature; roll it into slabs on glass or porcelain plates with a glass or porcelain roller, and after drying it will receive a beautiful ivory surface by polishing, which may be done by, first, fine rottenstone and then rouge, using chamois-skin. Prepare it by the ammonio-nitrate of silver process and print from a negative as usual with paper. Care must be taken not to soak the substance. The solutions must be poured on gently.

Artificial Light in Photography. Since the introduction of the highly sensitive gelatine dry plate the use of artificial light has become not only possible, but general, in many photographic processes. The lights used are electric, gas, magnesium, aluminium, lime, and various mineral oils. In England Van der Weyde uses the electric light exclusively for portraiture, while Kurtz, Rockwood, and others in New York and elsewhere have adopted similar methods with complete success. In the January, 1894, number of *Wilson's Photographic Magazine* was given a portrait study by Strauss, taken by the aid of an incandescent light of 100-candle power. Generally speaking, however, the arc light

is used for this purpose, and also in many photo-mechanical and enlarging establishments for copying, enlarging, and printing. When gaslight is employed, Sugg's or Wigham's burners are used; fine results have also been obtained by means of the incandescent system of gas-lighting. By the use of ordinary gaslight house and commercial interior work is rendered easy of accomplishment, orthochromatic plates being advised in this connection. The uses of magnesium and aluminium in various forms are manifold, and suggest themselves particularly for dark and confined interiors, such as caves, grottos, etc. In Berlin, Herr Schirm operates a portrait studio by magnesium lighting used exclusively. Lime-light and the light of mineral oils are used with advantage in enlarging and printing bromide and chloride papers and plates. The subject of photography by artificial light is too extensive to admit of detailed treatment here; fully detailed accounts of its applications may be found in Vogel's *Progress of Photography*, Duchochois' *Photography at Night*, the *Mosaics* of recent years, and by consulting a file of any photographic journal.

Artigues' Process. A method of carbon printing invented by M. Artigues, of Bordeaux, in 1889, which is now becoming widely known and appreciated in Europe. A thin film of gelatine is coated on paper, and when set is sprinkled with black powder. When dry it is bichromated from the back of the paper. Development is effected by mixing white sawdust with hot water, and applying it to the print (exposed) while held in a vertical position. The prints obtained by this method have certain peculiar qualities not obtained by older processes, and its application in photo-mechanical processes renders it extremely interesting. Artigues' paper may now be obtained commercially.

Artotype. A name given to a photo-mechanical or photo-lithographic process. Much the same as the collotype or phototype.

Art Principles. The rules of art as laid down by the old masters, which involve the application of composition, light and shade, and of the trained eye to the production of pictures. "To walk is natural; to dance is an art." To make photographs is easy; to make pictures is an art.

Asphalt. A pitchy substance; brown-black; soluble in ether, benzine, spirits of turpentine and chloroform; loses its solubility by exposure to light. When thus made insoluble it resists the etching action of acids and is used in different photo-mechanical processes. (See *Asphaltum*.) Varnish is also made from it. (See *Bitumen*.)

Asphaltum (or Bitumen) Process. If a zinc, copper, or stone plate is coated with a solution of asphaltum in ether, chloroform, or lavender oil, dried in the dark, and exposed to light under a negative, the parts affected by light become insoluble, while those protected from the light by the dense portions of the negative remain soluble and may be washed off with one of the above solvents, when the plate may be etched with dilute acid. This is the foundation of several photo-mechanical processes.

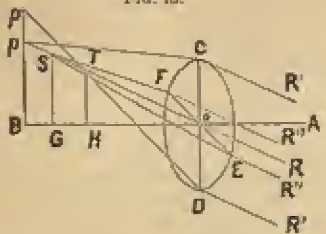
Asphaltum Varnish. Boil 500 parts of asphaltum, mix well with 250 parts of linseed oil, and when cool add 250 parts of spirits of turpentine. Is used for coating and repairing dishes.

Astigmation. This word is derived from the Greek, and means "not coming to one point." If we focus a well-defined round object, situated in the axis of a lens of a wide aperture, on a screen, we find the image round; even if we move the screen in and out of the focus, the image will get only less sharp; but if we turn the lens sideways, so as to get the image of the same object formed by pencils oblique to the axis, then we will observe that it is no longer possible to form a sharp image of the object, and by moving the screen in and out of the focus the image appears elongated, horizontally or vertically.

Now let us see whether it can be made clear be the following figure (13). $C\ D$ is a convex lens, of which $A\ B$ is the axis. The lens is represented in perspective, as we have to show two planes, in different directions. The radiating point R is situated at infinity, and outside of the principal axis. We will lay a plane through the axis $A\ B$ and the point R, which will cut the lens in its diameter $C\ D$. Let us lay another plane through the point R, at a right angle to the former, and which will cut the lens in its diameter $E\ F$. If we draw the line $R\ p$ through the optical centre of the lens, a ray following it would not be refracted, as we have seen before, and constitutes a secondary axis. $R\ p$ is the line where the two planes cut each other, and consequently belongs to both planes. Let us draw the two extreme rays,

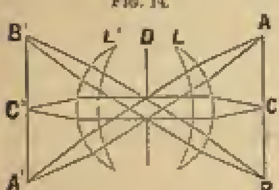
$R' C$ and $R' D$ of the diameter $C D$, which, after refraction, are T and p', as we learned by analyzing spherical aberration. If we now look to the other plane, the rays $R'' F$ and $R'' E$ are symmetrical to the axis, and

FIG. 13.



are exactly equally refracted, meeting at the point S. If the lens is now diaphragmed down, so as to improve the aberration of the plane $C D$, we find that we have for one lens two distinct foci. If we focus, for instance, a brick wall, we will have the horizontal white mortar lines in focus, while the vertical ones are out of focus, and *vice versa*. By looking to the figure you can easily see that that universal doctor in optics, the diaphragm, will also cure astigmation, at least will bring it to a minimum. Fig. 14 will suggest a way by which astigmation may be destroyed almost completely. The diaphragm D divides the lens L into an infinite number of lenses, of which each acts on a different radiating point, and the pencils in or out of the axis strike the lenses almost normally, hence such a combination is not only nearly free of distortion, but of astigmation also.

FIG. 14.



Astrometeoroscope. An instrument devised by Pilcher, for use with the optical lantern, by means of which the screen is made to appear as if covered with a network of geometrical designs which constantly change their form.

Astronomical Photography. When Arago, in 1839, first enunciated before the Academy of France the process of Daguerre, he referred to the possibility of the usefulness of photography in astronomical research. His prediction has been wonderfully verified, and to-day the applications of photography in astronomy are so important and various that, to describe them, a volume would hardly suffice. As a general thing, however, astro-photography requires special apparatus and equipment, and is therefore beyond the capacity of most workers. An interesting *résumé* of the means used in this branch of work is given in Abney's *Treatise on Photography*.

Solar Photography comprises the photographic study of the solar surface and phenomena. The earliest achievement in this direction was the daguerrotype of the solar prominences, obtained by Berkowsky in 1851. Since the gelatine dry plate has been introduced into spectroscopic investigation, the work of solar photography has made great progress.

Lunar Photography, the study of the moon in its phases and phenomena, was first attempted by Draper in 1840, who succeeded in obtaining a daguerrotype of the moon after some hundreds of trials. Afterward, in 1852, by the wet collodion process, De la Rue obtained a superb lunar photograph, as also did Rutherfurd at a later date. The finest recent photographs of the moon obtained are probably those by the brothers Henry, of Paris, made in 1890–91.

Stellar Photography is, perhaps, the most widely useful of all branches of astro-photography, and comprises the photography of the planets, stars, etc., recording the number and magnitude of stars and mapping the heavens. The current astronomical journals give a record of the progress, year by year, of all these applications, and should be consulted by those interested.

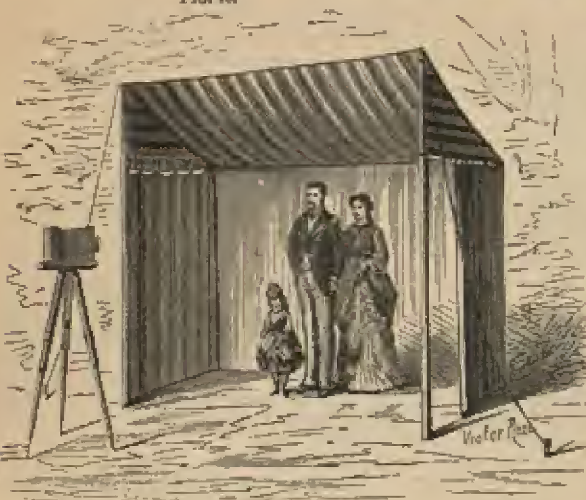
Astro-Photography. The application of photography to the study and observation of the stars.

Atelier. Glass-house; studio; furnished with sky- and side-light and needed arrangements for regulating the light when making photographic exposures.

Atelier Camera, or portrait camera, a camera for making pictures in the studio; should be adapted for all kinds of photographic work rather than distinguished for its lightness (desirable in travelling cameras); easy to focus with accuracy; manageable upon the stand; supplied with all modern improvements, and of pleasing form.

Atelier, Portable. Use a gray-blue cloth background, about 6 feet wide by 7 feet high. The top and the sides form curtains, are made of thin stuff, and held by rings to the

FIG. 15.



rods of the frame-work. All may be taken apart with ease and rolled around the support pole for carriage.

Atelier Stand. A camera-stand for the studio; on casters; easily lowered or raised or tipped; massive, and with top capable of elongation.

Atmospheric Influence. The action of the atmosphere on substances. In photography, its effect is in retarding or increasing photogenic development by the solar rays.

Atom. A particle of matter so minute as to admit of no division—the first principles or component parts of all bodies. In *chemistry*, a supposed ultimate particle or component part of a body; the smallest particle supposed to result from the division of a body without decomposition.

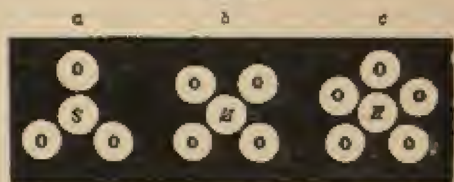
Atomic Theory. This theory was proposed by Dalton and facilitates the comprehension of chemical reactions.

It is supposed that all matter is made up of an infinite number of minute atoms, which are elementary, and do not admit of further division. Each of these atoms possesses an actual weight, although inappreciable by our present methods of investigation. Simple atoms, by uniting with each other, form *compound atoms*, and when these compounds are broken up, the elementary constituent atoms are not destroyed, but separate from each other, in possession of all their original properties.

In representing the simple atomic structure of bodies, *circles* may be used, as in the diagram given below (Fig. 16).

a is a compound atom of sulphuric acid, consisting of an atom of sulphur united intimately with three of oxygen; *b* is an atom of peroxide of nitrogen and four of oxygen, N_1O_4; and *c* an atom of nitric acid, composed of nitrogen one atom, oxygen five atoms, or in symbols N_1O_5. All atoms are not of the same weight, those of one element being either lighter or heavier than those of another; thus, an oxygen atom is sixteen times as heavy as an atom of hydrogen. (See *Atomic Weights*, below.)

FIG. 16.



Atomic Weights. Weights or proportions in which chemical elements combine.

If we suppose that the simple atoms of different kinds of matter *differ in weight*, and that this difference is expressed by their equivalent numbers, the laws of combination follow by the simplest reasoning. It is easy to understand that an atom of one element or compound would displace or be substituted for a single atom of another; therefore, taking as the illustration the decomposition of iodide of potassium by chlorine, the weight of the latter element required to liberate 126 grains of iodine is 36 grains, *because the weights of the atoms of those two*

elementary bodies are as 36 *to* 126. So again, in the reaction between chloride of sodium and nitrate of silver, a compound atom of the former, represented by the weight 60, reacts upon a compound atom of the latter, which equals 170.

Therefore in the place of the term "equivalent" or "combined proportion," it is more usual to employ that of "atomic weight." Thus take the atomic weight of oxygen (represented by the symbol O) as 8, and that of sulphur as 16; the atomic weight of the compound atom of sulphuric acid, or SO_3, will be equal to the combined weights of the four simple atoms; *i. e.*, 16+24=40.

Aurine. A dark gum-like substance made commercially by heating a mixture of phenol, oxalic acid, and sulphuric acid, resulting in a crude product. This is dissolved in warm ammonium hydroxide and permitted to cool, when a crystallized precipitate is obtained which is purified with alcohol. Aurine is insoluble in water, but freely soluble in alcohol or ether, and is used to dye fabrics for dark-room window use, or to back dry plates to avoid halation, being for this purpose mixed with collodion.

Auro-Chloride of Sodium. A compound consisting of gold, chlorine and sodium. To make it, dissolve 1 drachm pure gold in aqua regia (see *aqua regia*), and evaporate to dryness; redissolve and add 100 grains carbonate of soda, stirring till complete solution; then again evaporate to dryness and bottle. This is a most excellent substance for toning. The bath may be made in the following proportions: Auro-chloride of sodium, 1 grain; chloride of lime, ½ grain; hypo. soda, 42 grains; water, 1 ounce. This forms an alkaline bath which admits of great depth of color without sulphurization.

Aurotype. Photographs upon paper produced by a preparation of gold, the discovery of Mr. Robert Hunt. The process is not of much importance practically.

Auro-Uranium. A compound of gold and uranium.

Auro-Uranium Process. A method of printing positive photographic proofs by the salts of uranium and gold. (See *Uranium Process*.)

Autocopist. An apparatus introduced by a Parisian firm, by means of which phototypes can be made in a very simple way. The print is made from parchment sheets, sensitized by bichromate of potash. A common letter-press answers for printing.

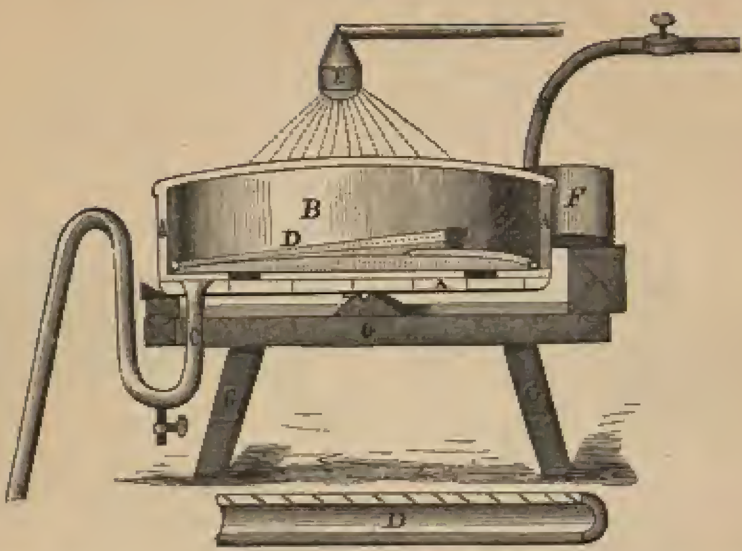
Autography. A process for transferring drawings to stone or zinc for lithographic printing. The drawing is done with lithographic ink on gelatinized paper, which is then laid, face down, upon a clean stone or zinc plate and pulled through the press. The paper is then wetted from the back, the gelatinous preparation softens so that the paper may be removed, leaving the drawing on the stone or plate as if drawn upon it. Crayon drawings may be transferred in this manner if a grained gelatinized paper is used.

Automatic Development. A development which, with a normal developer, always, within a given time, produces the best possible negative.

Automatic Photography. During the last few years various machines have been introduced which will expose, develop, and fix a ferrotype portrait while the person desiring to be photographed is seated before the machine. They operate upon the principle embodied in the nickel-in-the-slot instruments.

Automatic Washing Tank. Designed by Overbeck. The machine is constructed on the siphon principle, and consists of a large tin bath lying on a rod, which is kept backward by counter weights, and as soon as filled with water to a certain height will fall forward, when a siphon attached is filled, and will quickly take out all water. At this stage the counter-weight acts, the bath falls back, new water flows in, the siphon plays again, and this continues as long as there is water flowing in. The water comes through many small holes that are cut in lead pipes lying in the bath. The direction of the holes is such that the water is continually kept in motion, and the print with it. Sometimes water is let on through a rose over the bath, as is seen in the cut. *A*, a cylinder of zinc, 24 inches in diameter and 6 inches high; *B*, an inner cylinder, the bottom of which is pierced with holes; *C*, a supply-tube with siphon; *D*, a lead pipe pierced with holes, the holes being in such directions that the water in the cylinder is kept in motion; *E*, a rose; *F*, a box for the counter-weights; *G*, the stand upon which the machine is placed. The figure (Fig. 17) shows the parts so plainly in detail, that further explanation would be superfluous.

FIG. 17.



Autotype. (See *Carbon Process.*)

Aux-Deux Crayons. A name given to vignette photographs which have been dyed to a warm tint by immersion in a solution of garancine or other dye, and afterward worked upon with the brush and white color to give them a "crayon" effect.

Avoirdupois. The English trade or commercial weights:

Pound.		Ounces.		Drachms.		Grains.		Grammes.
1	=	16	=	256	=	7000	=	453.59
		1	=	16	=	437.5	=	28.35
				1	=	27.34	=	17.7

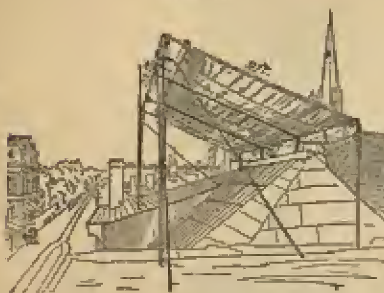
Awning for the Skylight. Mr. John Reid describes his system as follows: "I have an unobstructed north light, 12 x 14 feet, at an angle of 40 degrees, lowest point 7 feet from the floor, with side-light 5 x 2 feet, 2 feet from the floor. My awning-frame is made of 1¼ inch galvanized iron pipe, 23 feet long by 9 feet wide, with 2 middle bars, 9 feet long and about 7 feet 6 inches apart. The frame is supported at the peak of the skylight by studs 1 foot high, which allows the free passage of wind. From the peak of the skylight the frame rises at an angle of about 18 degrees, the whole properly braced and fastened to the roof. The awning, 8½ x 23 feet, is made of drilling, securely tied to the bar on the peak of the skylight, and with rings on the side and middle bars, so that it will slide up and down free and clear of all obstruction. On each of the 23-feet sides are fastened two pulley-blocks,

FIG. 18.

through which pass ropes, for the purpose of raising and lowering the frame by a sliding motion. Thus it will be seen that all that is required is to raise it in the morning, tie it

securely, and lower it at night, or on the approach of a heavy wind or storm. As will be seen from the above description, the awning extends east and west about 5½ feet over the light, thereby cutting off the rays in the early morn and late in the afternoon; and on the north side extending up, and by drop-

FIG. 19.



ping a plumb-line, would cover about two-thirds of the light, thus shielding the light completely from the sun."

Axis. A straight line, real or imaginary, passing through a body. In *optics*, a particular ray of light from any object, which falls perpendicularly upon the eye. It is sometimes called the optic or visual axis.

Axis, Optical. An imaginary line passing through the centre of the lens combination.

Azaline. A color sensitizer used in orthochromatic photography, composed of a mixture of quinolin-red and cyanin-blue. This name is also given to the nitrate of rosaniline sold as rubine. The solution as used for orthochromatizing is made by dissolving 15 grains quinolin-red and 1¼ grains cyanin-blue in 20 ounces of alcohol, which solution is of an intense carmine color.

Azotate. A salt formed by the union of azotic acid with a base.

Azotate of Silver. (See *Nitrate of Silver.*)

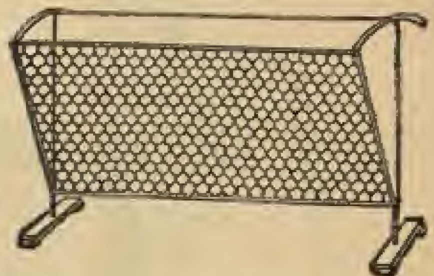
Azotic Acid. (See *Nitric Acid.*)

B.

Background. A frame covered with paper or cloth, placed behind the sitter to assist the illumination and to embellish the picture. It is made either plain, graded, or scenic.

Background, Chromatic. A form suggested by Dr. Dorat, the effect of which is very good. It consists of two wooden frames of any size required; one of them, on feet as usual, is covered with a light yellow canvas or cloth, strained on it or not. The screen stands perpendicular upon the floor; at the lower part is attached the other frame, by

FIG. 20.



means of a couple of hinges, and rising at an angle of 44°; two small slips of wood secure it in this position at the upper part of the first frame. This is covered with a well-strained piece of black or brown lace, easily procured at large stores in the city. It is mostly used by frame-makers, and is three yards wide; being white it can be dyed to the requisite tint.

FIG. 21.

Background, Circular. This is the invention of C. W. Motes. It consists of a muslin

disk mounted on framework which revolves on an axis fixed to an ordinary head-rest. The diameter is four and a half feet. Unbleached muslin painted with a neutral tint and graduated, is used. It is revolved at the moment of exposure, or it may be worked back and forth by the hand, part way only.

Background, Cone. The invention of W. Kurtz. It is made of papier-maché, six feet in diameter by three feet deep, mounted on a rod which fits any ordinary head-rest stand; the latter is fastened to a wooden platform on casters, and is furnished with a handle, A. As the whole affair weighs but a few pounds, it can readily be moved and adjusted to any part of the room or light. The interior is painted or sanded to any degree of shade desirable. It will be readily understood that any light coming from one side must illumine that part of the interior far-

FIG. 22.

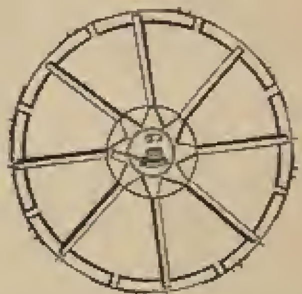
FIG. 23.

thest from it, and *per contra* leave the nearest side in comparative shade. By turning it full to the light, there is no shade, and you get a very light background; then upon turning it from the light, you get it *almost black*, if you wish to.

Background Frame. The figure illustrates a device suggested by Mr. Charles Wager Hull. By the use of the frame or stand, and proper pulleys, the backgrounds not in use are simply let down to the floor. (See Fig. 23.)

Background Stretcher. The users of circular backgrounds are often troubled by their wrinkling. Mr. F. E. Lussenhop has devised an expansive frame which will prevent the trouble named. As will be seen from the accompanying cut, the frame resembles

FIG. 24.



a wheel, each spoke of which supports a separate piece of the outside ring. By turning the screw in the centre the different pieces expand, straightening thereby the background, which is tacked on to them.

Backing. Covering the back of a dry plate with non-actinic color, paper, etc., to avoid reflection or halation during exposure. The act of laying on black varnish or other substance behind a glass positive to render the shadows visible or give better effect to the picture.

Backing Ambrotypes. This may be done by spreading asphaltum varnish on the reverse side of the glass plate, or by placing black cloth or paper in the bottom of the case that holds the picture.

Backing Plates. In order to avoid halation or blurred light effects when gelatine dry plates are used for interiors or brilliantly lighted landscapes with foliage, the backs of the plates require to be coated with some non-actinic (black) substance which must be

in optical contact with the plates. This can be effected by using a plain collodion stained with red aniline or turmeric dye; or yellow paper is moistened with glycerine and water and squeegeed on to the back of the plates before placing in the holder. Abney recommends the following mixture, to be brushed over the back of the plate with a broad, soft brush:

Powdered Burnt Sienna	1 ounce.
Powdered Gum-Arabic .	1 "
Glycerine	2 ounces.
Water	10 "

This backing is easily removable before development. Another good method is to smear a drop of glycerine on a piece of black enamel paper of suitable size and squeegee this to the plate. The most satisfactory way to avoid halation, however, is the use of non-halation plates, such as those of Carbutt, Seed, and others.

Backing Transparencies. This is performed in various ways, the most common being to place a piece of ground-glass in contact with the collodion film. Plain glass may be used, if afterward varnished. Opal glass is also used, but requires stronger light when viewing the picture. A very pleasing effect is given by using glasses slightly tinted with warm colors. The method of backing is simply to place the backing-glass, after cleaning, over the collodion side, with or without a thin paper diaphragm between. Seal the edges with black paper and gum.

Fig. 25.

Fig. 26.

Back Support. A little instrument to attach to the ordinary head-rest to support the backs of infirm persons and children during the exposure of the plate in the camera.

Bag Changer. An arrangement for changing the plates, in the form of a bag.

Balance. An element in the composition of a picture. It relates to the balance or compensation of the lines in the picture; thus the lines of one side of a pyramid balance the lines or compensate those of the other side. This is merely carrying out an involuntary principle of nature which we may see in almost everything man attempts. In every picture there are points which are more prominent than the others and to which all parts are made more or less subordinate. By the careful arrangement of the lines and masses of light and shade, we secure the prominence due to each object. In a

landscape, for example, the foliage, the trees, the shrubbery, in fact, all of the elements of a picture are needed to help secure the proper balance. This may be illustrated by the two engravings herewith. It will be observed in Fig. 25 that there are two diagonal lines nearly parallel with each other, which rise from the right-hand lower corner of the picture, the one starting from behind the man firing at the ducks, following over his head, over the shrub to his left, behind which he is kneeling, across the stream to the old castle nearest the water, over the church spire, on up to the mountain top. The other starts in the highest shrub on the right, whence the eye is carried across the picture by the white cloud in the sky, which completes the second diagonal line. Now, in Fig. 26 the shrubs and the figures of the man and dog are removed, with a part of the river bank; observe the wondrous difference. Our lines are destroyed; the necessary balance is removed, and the groups of buildings look as if they had nothing to stand upon and were about to topple over into the water. The lines running to a point in the distance appear to want collecting together and regulating; the distance itself comes forward into the foreground, and the parts do not take their proper relation to each other. There is a sense of completeness in the one which we cannot recognize in the other.

Balloon Photography. The principal difficulty in taking photographs from a balloon lies in the rotating movement of the balloon and in the shaking or trembling of the basket. The least movement of the person inside communicates itself to the balloon. Therefore, the most unfavorable time for taking a picture is in a first ascent. At the instant that the balloon rises from the earth a rotating motion is experienced, which makes it impossible to obtain accurate pictures, even with a very short exposure. The balloon is, moreover, moved by the currents of the air in the direction of the wind. When at a height of 1000 metres, with a moderate wind of only ten or twelve miles per hour, it is necessary to expose only one-tenth second; when 500 metres high, one-twentieth second suffices, if a tolerably accurate picture is desired. (See Fig. 27.)

FIG. 27.

Balsam of Fir. The juice of a species of fir-tree found in Canada and northern parts of the United States. It is used in photography for sealing lenses, ambrotypes, lantern and stereoscopic slides.

Balsamo's Printing Process. This process, which involves a new principle in photography, was the discovery of Professor Joseph G. Balsamo, of Lucca. Phosphorus is digested for a considerable time in hydrochloric acid at the ordinary temperature, or, if time be an object, at a temperature of about 120° or 140° F. The older this solution becomes, the higher the photogenic properties it acquires. After saturating the hydrochloric acid with phosphorus it is diluted with acetate of copper until the liquid assumes a deep olive-green color. To prepare the paper, the liquid is poured into an earthenware or porcelain dish, and each sheet is immersed therein for three or four minutes. The paper is exposed under the negative until it has attained a gray color. When withdrawn from the pressure frame the paper is exposed for about five minutes to the vapor of sulphuretted hydrogen, which has the property of attacking those parts upon

which the light has acted. The impression being thus fixed, the paper is washed in abundance of water to remove the superfluous salts of copper, and the details appear with great sharpness. In order to render the impression more stable, and also to tone it, the proof is soaked in the nitrate of bismuth. This bismuth, substituted for copper, constitutes the impression, fixes it, and tones it more or less deeply, according to the length of exposure, intensity of light, and strength of the bismuth bath.

Barium is a metal, discovered by Sir H. Davy in 1808. In appearance it is of a dark-gray color, with a lustre inferior to cast iron. It is obtained by making a paste of the carbonate of baryta and placing in a small depression in its surface a globule of mercury. The paste being put on a piece of platina in contact with the positive wire of a powerful galvanic battery, and the negative wire made to communicate with the mercury, the baryta is decomposed, the barium unites with the mercury, forming an amalgam, from which it is separated by heating the compound in a vessel free from air, at a temperature sufficient to drive off the mercury. Barium is heavier than water, sinking in sulphuric acid; it has a powerful attraction for oxygen, taking it from the air and water, and forming a white powder.

Barium, Chloride of. (See *Chloride of Barium.*)

Barnes' Dry Collodion Process. Like all other photographic processes, this requires care and cleanliness. The plate, after being perfectly cleaned, is first coated with plain collodion, and then with albumen, made as follows: Take the whites of 2 eggs and mix with 4 ounces of distilled water, stirring for five minutes; then add 30 drops glacial acetic acid and stir; filter several times through the same paper. After pouring upon the plate, dry over the spirit lamp or a stove. After drying, sensitize and dry again. Expose and develop with the following solution, after dipping in water:

Saturated solution Gallic Acid	4 ounces.
Distilled Water	4 "
Pyrogallic Acid	4 grains.
Acetic Acid	1 drachm.

Intensify with a 30-grain solution of nitrate of silver.

Barometer. An instrument for measuring the variations in the pressure of the atmosphere. Invented by Torricelli in 1643.

Baryta. *Oxide of Barium.* This salt is composed of 1 part of oxygen to 1 of barium. It is a gray powder, procured by exposing the nitrate of baryta to a red heat; or by mixing the native carbonate in powder with charcoal powder, and exposing it to a white heat in a black-lead crucible. It is highly alkaline, converting vegetable blues to green, and neutralizing the strongest acids; it is, however, less caustic than potassa and soda, and is insoluble in pure alcohol. Like lime, it slacks when in contact with water, forming a white hydrate, which is fused at a red heat, but will not part with its water at the highest temperature of a smith's forge; it dissolves readily in water, the solution being attended with a great evolution of heat and light. It is used in combination with lime and bromine as an accelerator, but its utility is doubtful.

Baryta Paper. Raw paper coated with baryta, variously tinted and used for collodio-chloride of silver and gelatino-chloride of silver paper, the baryta substratum preventing the sinking-in of the picture into the pores of the paper.

Base. The electro-positive ingredient of a compound or salt. Any alkaline or earthy substance combining with an acid forms a compound or salt, of which it is the *base.* Such salts are called alkaline or earthy bases (*Webster*). A term applied to metallic oxides; for instance, soda is called the base of sulphate of soda; silver is the base of nitrate of silver.

Bases. Chemical combinations containing oxygen, sulphur, or hydrogen, forming salts with acids; bases, soluble in water, color red litmus paper blue, curcuma paper brown (with alkali reaction); for instance, caustic potash, lime. The bases of heavy metals are insoluble in water, and consequently not alkaline in reaction; but there are exceptions—oxide of silver and oxide of lead, for instance, are slightly soluble in water, and react feebly alkaline.

Base-Board. The horizontal foundation-board of a camera, upon which the latter is built and upon which it is moved back and forth when focussing; supplied with setting screws of various designs. In large cameras a spindle-screw is usually attached to the base-board (which in these is generally a double one), by means of which the back

part of the camera may be moved to and fro with ease.

Bath. This term is variously applied in photography. The vertical vessel containing the sensitizing solution is called a bath, and also other vessels; the sensitizing solutions, toning solutions, fixing solutions, etc., are termed baths. (See *Nitrate Bath*, *Toning Bath*, etc.)

Bath-Holder. A contrivance for holding the sensitizing solution for dipping wet

FIG. 28.

plates. It consists of a glass holder protected by a wooden case, and, when not in use is closed by the adjustable top with clamps, as shown in the figure.

FIG. 29.

Bath-Warmer. A contrivance for securing gentle warmth for developing and fixing solutions as well as the nitrate bath. In summer-time a dish of ice instead of a lamp will keep all cool. The apparatus may be cheaply and easily made, consisting only of a wooden box on feet, with folding doors, a support for the bath-holders, and a cover. *L* is an alcohol lamp placed under this box, the chimney running up through a piece of tin at *T; D D* are the doors. When the latter are closed a very small flame will create an amount of heat quite sufficient for the desired purpose. The box should be made of light wood and of a size to suit the requirements of the operator. (Devised by E. Long.)

Beam of Light. A collection of parallel rays.

Bayard's Toning Process. In 273 ounces of water dissolve 15½ grains of chloride of gold, and add it, in small quantities at a time, to the following solution: Water, 273 ounces; hyposulphite of soda, 77½ grains; chloride of ammonium, or common salt, 232½ grains. The mixture, which is at first orange-red, soon becomes colorless, and is then ready for use. Wash the print in water, and immerse it in this bath. The tone it assumes is at first red, then violet, then black, and finally blue. To stop the action, remove the print and immerse it in a fresh bath of hypo, strength 15 per cent. Leave it there a quarter of an hour, and wash and finish in the usual way. The hypo affects the tone very slightly; the proofs, therefore, should not be printed too deep.

Bellows. The pleated calico, rubber, or leather construction which unites the front and back portions of the camera is called the "bellows." This, when extended, should measure three times the length of the longest side of the plate for which the camera is intended. The interior of the bellows should be kept well blackened, light-tight, and clear from dust, to avoid fog, reflections, and pinholes in the negatives. The bellows is made both square and conical.

Bellows Camera. A camera the sides of which are made of leather, rubber, silk, or similar material, folding like an accordeon.

Benzene. C_6H_6. Syn., benzole. A colorless, volatile, inflammable liquid with characteristic odor. It is used as a solvent for caoutchouc in preparing rubber varnish, and also for dissolving asphaltum in photo-mechanical processes. A solution of amber in benzene may be used as a cold varnish for

negatives and positives. For varnishes benzole is preferable.

Benzine Varnish. This varnish is made by dissolving gum damar in benzine, and filtering. Any consistency desired may be obtained. Pure benzine, and none other, must be used, as the adulterated articles give a tacky character to the varnish and cause it to stick to the paper when printing. Used for varnishing negatives.

Benzine Waxed-Paper Process. (See *Camphene Waxed-Paper Process.*)

Benzoic Acid. This acid consists of 15 parts carbon, 3 parts oxygen, and 6 parts hydrogen. It exists ready-formed as a constituent of all true balsams, and is obtained by sublimation and other means from the gum benzoin of commerce.

Benzoin Varnish. An excellent negative varnish, made as follows: Gum benzoin, 45 grains; alcohol, 1 ounce. Powder the gum, and gradually add it to the alcohol; when all is dissolved, filter. It will be found almost impossible to get this varnish off the negative, so none but the best should be varnished with it. For ambrotypes, it can be used by first adding a little animal charcoal and filtering it. After it becomes quite hard the black varnish may be spread over it without fear of injuring the picture.

Benzole. Product from coal by distillation; colorless, of characteristic smell; a volatile liquid, very inflammable. Dissolves asphaltum, gum damar, rubber, etc.

Bicarbonate of Potash. It is made by passing a current of carbonic acid through a solution of subcarbonate of potassa, and evaporating the fluid at a low temperature. The vessel employed must be of sufficient thickness to resist the pressure of gas. When exposed to a red heat the bicarbonate loses half its acid and all its water of crystallization.

Bicarbonate of Soda. $NaHCO_3$. A white powdery mass, rather soluble in water. Used for neutralizing excess of acid in gold toning baths.

Bichloride of Bromine. An accelerator, the discovery of Mons. Dubois, which is highly spoken of. Two pounds placed in the coating-box will last over a year, at the expiration of which time 10 or 12 drops of pure bromine added to the compound will restore its accelerating property. It is prepared by passing an excess of chlorine through bromine kept at a low temperature.

Bichloride of Mercury. Bichloride of mercury, oxymuriate of mercury, or corrosive sublimate, is a well-known violent poison. Bichloride of mercury is applied in photography to intensify or *blacken negatives*, and to *whiten* positives on glass (ambrotypes). After the final washing of the *negative*, after fixing plunge it into a vertical bath of a saturated solution of the bichloride until it becomes perfectly white; wash it off and pour over it a solution of hyposulphite of soda, rinse again, and stand up to dry. To whiten *ambrotypes* plunge them into the saturated solution of bichloride for from a half-hour to an hour, wash and dry.

Bichromate of Ammonia. $NH_4Cr_2O_7$. Large red crystals. Its solution, mixed with organic substances (albumen, gelatine, etc.), becomes insoluble by exposure to light. Upon this characteristic are based the carbon process, the dusting-in process, Lichtdruck, Woodbury-type, photogravure, phototypography, photo-lithography, and photozincography.

Bichromate of Potash. A beautiful red-colored anhydrous four-sided tabular crystal, composed of 2 parts of chromic acid and 1 of potassa. It was first made by Mr. Ponton. Paper immersed in a solution of bichromate of potash is powerfully and rapidly acted on by light. This paper is not sufficiently sensitive for the camera, but answers an excellent purpose for taking drawings of dried plants or copying prints. To effect this give the paper a sizing of starch, steep it in a weak solution of iodine, and then wash it in a large quantity of water, when it will take a very fine blue tint. If this is not uniform the paper must be re-sized, and again soaked and washed. It is then soaked in a concentrated solution of the bichromate of potash, the superabundant moisture taken off with blotting-paper, and dried thoroughly by the fire. When the copy is obtained it is washed, dried, and steeped in a weak alcoholic solution of iodine for fifteen or twenty minutes, and carefully dried with blotting-paper. If the drawing is not sufficiently distinct this soaking and drying may be repeated, and if a layer of gum-arabic is applied while still wet, although it at first loses a little of its tone, it is greatly improved and rendered more permanent when dry.

Bichromate of Sodium. It has recently been recommended by Husnik, of Prague, as a substitute for bichromate of potash in

all gelatino-chromate methods of photo-mechanical work. It is cheaper, weight for weight, more active, and more soluble, and therefore less liable to crystallize in the gelatine.

Bichromate Poisoning. Bichromate of potash, largely used in carbon-printing and photo-mechanical work, is a poison, acting locally, when absorbed by the skin, as an irritant, causing sores and ulcerations, especially when the skin is abraded. It is well to handle this salt with extreme care, either in powdered form or in solution, the dust arising from friction of the crystals giving rise to distressing catarrh; while in solution absorption by the cuticle is rendered easy by the slightest abrasion. The following ointment is given in the British Pharmacopœia as a remedy:

Mercury (by weight)	4 ounces.
Nitric Acid	12 fluidounces.
Prepared Lard	15 ounces.
Olive Oil	32 fluidounces.

Dissolve carefully at 212° F., and mix thoroughly, stir until cold, and use as a salve. (See *Carbon Process.*)

Biconvex. Having two convex surfaces; *i. e.*, a double convex lens is bounded by two convex spherical surfaces, whose centres are on opposite sides of the lens. (See *Convex.*)

Binary Compounds. A term used in chemistry to denote a compound containing two elements. All the chemical names of such compounds end in *ide*. Thus "red precipitate," which is composed of oxygen and mercury, is known as *mercuric oxide*.

Binding Lantern Slides. (See *Transparencies.*)

Binocular. Having two eyes; having two apertures or tubes, so joined that a person may use both eyes at once in viewing a distant object.

Binocular Camera. This instrument differs from the common camera in having two lenses with the same aperture and focal length, for taking at the same instant two pictures of the same object at the distance of six feet, or any other distance.

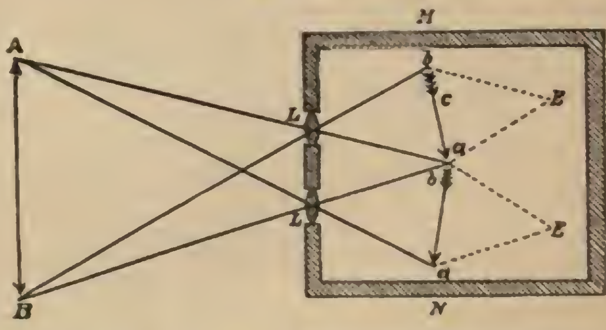
The two lenses of the binocular camera should be placed so as to have their diameter of direction parallel to each other, and perpendicular to the horizon, at the distance of 2½ inches apart, as shown in Fig. 30, where $M N$ is the camera, L L the two lenses, placed in short tubes, so that by the usual mechanical means they may be directed to the object or have their axes converged upon it, as shown in the figure, where $A B$ is the object and $a b$ its image, as given by the lens L and $a b$ as given by the lens L. These pictures are obviously the very same that would be seen by the artist with his eyes at L and L, and as $A L B = a L b = a L b$, the pictures will have the same apparent magnitude as the original, and will in no respect differ from it as seen by each eye from E E, $E a$ being equal to $a L$, and $L a$ to $a L$.

Binocular Perspective. The space and distance to the eyes viewing the objects.

Binocular Photography. The application of the principles of binocular vision to photography, producing the stereograph.

Binocular Vision. The natural vision of the two eyes. In the binocular vision of objects each eye sees different pictures of the same object. In order to find confirmation of this fact we have only to adopt the

FIG. 30.



expedient of pressing upon one eye and to observe the image which belongs to it separate from the other, and again unite with it when the pressure is removed. It might have been supposed that an object seen by both eyes would be seen twice as brightly as with one, on the same principle as the light of two candles combined is twice as bright as the light of one. That this is not the

case has long been known, and it has been proved that the brightness of objects seen with two eyes is only one-thirteenth part greater than when they are seen with one. The cause of this is well known. When both eyes are used the pupils of each contract so as to admit the proper quantity of light; but the moment we shut the right eye the pupil of the left dilates to nearly twice its size, to compensate for the loss of light arising from the shutting of the other.

This beautiful provision to supply the proper quantity of light when we can use only one eye answers a still more important purpose, which has escaped the notice of optical writers. In binocular vision certain parts of objects are seen with both eyes, and certain parts only with one; so that, if the parts seen with both eyes were twice as bright, or even much brighter than the parts seen with one, the object would appear spotted from the differing brightness of its parts.

A person with one eye cannot readily distinguish the form of a body which he had never previously seen, but quickly and unwittingly moves his head from side to side, so that his eye may alternately occupy the different positions of a right and left eye; and if we approach a candle with one eye shut, and then attempt to snuff it, we shall experience more difficulty than we might have expected, because the usual mode of determining the correct distance is wanting. (See *Stereoscope*, etc.)

Biot's Dry Process. This process is said to be a decided improvement on the original Taupenot's process. *The Collodion:* Normal collodion, without alcohol, and containing 3 per cent. of pyroxyline; 25 parts sulphuric ether at 62°; 25 parts alcohol at 40°; 10 parts alcohol concentrated with iodide of cadmium, 5 parts. Pour the collodion on the glass as usual, then immerse it in a 30-grain nitrate bath for half a minute. Wash it in distilled water; let it drain a few minutes, and then pour over the film a sufficient quantity of the following preparation: Rain water, 2 ounces; dextrin, 5 drachms; iodide of potassium, 20 grains. Dissolve by means of heat, decant the clear liquid, and add to it the whites of 2 eggs. Beat the whole up to a stiff froth and let it settle, covered from dust. The glasses must be dried by a spirit-lamp. You must dry the plate until you see the bluish color of the iodide of silver change to a lemon-yellow, particularly at the edges of the glass. The glass having been dried and cooled is put for half a minute into a bath of distilled water, 100 parts; fused nitrate of silver, 6 parts; glacial acetic acid, 10 parts. When you remove the glass from this bath wash it with distilled water, and let it drain for a few moments; then wipe the back with a clean cloth, and rest it upon one corner to dry. The time of exposure depends upon the intensity of light, etc. Develop with distilled water, 1 ounce; gallic acid, 1 grain; acetate of lime, 1 grain. At the time of using the developer add 4 or 5 drops of fresh aceto-nitrate of silver solution. When fully developed, wash and fix with hypo, 1 part to 10 of water.

Bismuth. A metal existing native in a state of great purity. It dissolves entirely in nitric acid, from which water and alkalies throw down a white precipitate, and sulphuretted hydrogen a black one. The nitric solution is unaltered by adding sulphuric acid.

Bisulphite of Potash, Potassium Metabisulphite. $K_2S_2O_5$. In needle-like crystals, which, in distinction from common bisulphite, do not give off sulphurous acid in the air, consequently are stable. Soluble to 33 per cent. in water, insoluble in alcohol. Used as preservative in alkali development and in the preparation of an acid fixing bath.

Bisulphuret of Carbon, Carbon Bisulphide. CS_2. A colorless, volatile, bad-smelling liquid, insoluble in water, mixing with alcohol, ether, and fatty oils. Used in the preparation of varnishes, for removing the coat of varnish from glass, for dissolving sulphur, etc.

Bitartrate of Potash. $HKC_4H_4O_6$. A white acid salt, nearly insoluble in cold water.

Biting-in. A term applied to processes for etching in metal or glass by the agency of acids or other substances. It is applied to photography in heliographic engraving on steel, copper, and glass.

Bitumen, or asphaltum, is a substance of indefinite composition, containing varying proportions of carbon, hydrogen, sulphur, nitrogen, and oxygen; found in a crude state in California, Utah, Trinidad, and Syria; that obtained from the last-named source being the most esteemed for photographic purposes. Bitumen is insoluble in water and indifferent to acids, partly soluble in alcohol,

ether, and benzole, and very soluble in chloroform, carbon bisulphide, turpentine, and oil of lavender. It is so affected by oxidation under the influence of light as to be thereby rendered insoluble in its usual solvents, which property makes it useful in many photo-mechanical processes; it is also the base of most of the black waterproof varnishes now in use.

In order to make bitumen useful in the photo-mechanical processes purification is necessary. This may be effected in various ways, one of which is as follows: The commercial product is finely powdered and digested with alcohol for two hours in a closed vessel at 40° C., after which the residue is collected on a filter, washed with alcohol, and left for some days in contact with an excess of ether. The residue is finally air-dried and preserved in the dark.

To avoid this troublesome method of preparation, E. Valenta advises to heat together 100 parts of Syrian bitumen, 12 parts of flowers of sulphur, and 100 parts of commercial pseudo-cumene, which boils at 170° C., in an apparatus with a reflux condenser, for about three hours. The pseudo-cumene is then distilled off, and the residue dissolved in benzine for use. This mixture is very sensitive to light, and readily soluble in benzine, toluene, cumene, and turpentine.

Black Leather. The best for photographic purposes is the japanned morocco. Very pleasing positive pictures are produced on this substance, either direct in the camera or by transfer. They are peculiarly adapted for transmitting to distant places in letters by mail or otherwise. To make them direct in the camera, cut the leather to the desired size, and attach it to a piece of glass with a little balsam of fir or diamond varnish; collodionize it, immerse it in the nitrate bath, develop and fix in the usual way for glass positives or for the melanotype; detach it from the glass and hang it up to dry. *By Transfer:* First, cut your leather a little larger than the glass positive to be transferred; lay it, face upward, upon a table; then take ½ ounce of spirits of wine, and add 5 drops of nitric acid diluted with 4 ounces of water, and shake it up well. Take the positive, after drying, and pour the mixture over it, and while still wet lay it on the leather, face to face, gently pressing out the air-bubbles; then keep them in close contact in a pressure frame or between the leaves of a book until quite dry; the collodion film is then easily detached from the glass and remains firm to the leather.

Black Line Process. There are many methods of obtaining prints with black lines on a white ground, suitable for the reproduction of plans, etc. The following method is advised. Prepare the following solutions:

A.	Ferrous Sulphate	154 grains.
	Tartaric Acid	154 "
	Ferric Chloride	308 "
	Distilled Water	7 ounces.
B.	Gelatine	154 grains.
	Distilled Water (warm)	4 ounces.

Mix 1 and 2 and filter through flannel while warm. Sensitize suitable paper by lamplight with the mixture and use as soon as possible. Expose in direct sunlight under a drawing until the black lines of the drawing are visible as yellow on the sensitized paper. Then immerse the print in the following bath:

Gallic Acid	108 grains.
Oxalic Acid	15 "
Water	35 ounces.

The lines should develop a deep black; if the ground is tinted over, the print is under-exposed; over-exposure is shown by disappearance of fine lines. After development rinse the print well in clean water, remove the surplus moisture with absorbent paper (essential), and dry.

Goold's process is given as follows: Coat good stout paper by means of a brush or sponge with the following solution:

Water	12 ounces.
Gelatine	2¼ drachms.
Ferric Chloride	5½ "
Tartaric Acid	2½ "
Sulphate of zinc	2½ "

Expose in the printing-frame till the greenish-yellow color of the ground appears to be bleached out, and develop with

Gallic Acid	2¼ drachms.
Alcohol	7 ounces.
Water	34 "

The developer produces within three minutes perfectly black lines upon a white ground. With under-exposures the ground retains color, and over-exposures make the lines slightly gray.

Black Mirror. This is frequently recommended for photographing clouds or landscapes with their natural clouds by reflection.

Usually made of black glass, which is difficult to obtain and expensive. A piece of good mirror-plate, of course unsilvered, will do all that is required, if coated at the back with black varnish. It should be mounted in a frame fixed at the proper angle in front of the lens.

Black Oxide of Manganese. A mineral; serves with chlorate of potash for the production of oxygen for projections.

Black Spots. Troublesome visitors to the photographer, mostly caused by specks of dust settling upon the plate during some portion of the manipulation, from impure solutions or from particles of iodide of silver or organic matter held in suspension in the nitrate bath. They are best avoided by care and cleanliness in operating; in the case of the nitrate bath filtering will obviate the difficulty. Black spots are often produced on the collodion film by making the iron developer too strong, or by allowing it to remain too long on the plate.

Black Tones. These are best produced by strong gold baths. The following formula will be excellent (old):

Water	1 ounce.
Hypo. Soda	3 grains.
Aurochloride of Sodium	1 grain.

Black Varnish. In addition to the *asphaltum* there are several black varnishes for backing positives. Here are two formulæ for making the best. Take black sealing-wax and dissolve it to the proper consistence in spirits of wine, over hot water, or a sand bath. 2. To the ordinary asphaltum varnish add 2 parts of beeswax over hot water or a sand bath. In both cases they must be repeatedly stirred until thoroughly mixed. Or dissolve caoutchouc, ¼ drachm, in mineral naphtha, 10 ounces; add asphaltum, 4 ounces, and apply heat if necessary.

Bleach. To whiten; treating a negative with a solution of bichloride of mercury (for strengthening purposes) till it becomes more or less white. It is afterward blackened with ammonia or sulphite of soda.

Bleaching Prints for Photo-Engraving. When a photograph on bromide, plain silvered, or albumen paper is to be reproduced as a line sketch by photo-mechanical methods, the outlines and necessary shading are done upon the print with a waterproof ink, and the unnecessary detail of the photograph is then bleached out, leaving the sketch in fine black lines on a white ground. For bleaching prints on bromide paper, drawn as above, a weak solution of cyanide of potassium, to which a flake or two of iodine has been added, is recommended. Beach advises the use of the following:

Bromide of Copper Solution	½ ounce.
Hypo. Soda	100 grains.
Alcohol	1 ounce.
Water	2 ounces.

Those who make their own bromide of copper solution should mix these two solutions: (*a*) 120 grains bromide of potassium in 4 ounces of water; (*b*) 120 grains sulphate of copper in 4 ounces of water.

Prints on albumen paper, or plain silvered or a smooth matt-surface paper, re-drawn as above, may be bleached by immersion in a bath composed of a saturated solution of bichloride of mercury in alcohol, or water may be used in place of the alcohol with slower action.

Blind Shutter. A moderately quick shutter, consisting of a curtain, lifted by pneumatic action, and remaining so as long as the pressure continues.

Blistering. The forming of blisters in the film. In gelatine plates it occurs in the middle of the film, if on the edges, it is called frilling.

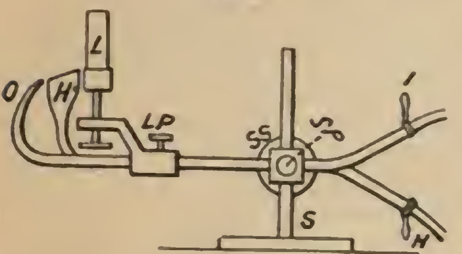
In the practice of photography the collodion film often blisters upon the glass from insufficiency of adhesion. This can be corrected by the addition of alcohol to the collodion when it is not caused by the glass being imperfectly cleaned. Grinding the surface of the glass with fine emery will also obviate the difficulty; but this last is rather an expensive method. Blistering of collodio-albumen plates may be avoided by first spreading the plate with a film of albumen of the strength of 1 ounce albumen to 6 ounces of water, filtered. Or a solution of gelatine, 2 grains to the ounce of water, with the addition of a little methylated alcohol. Blistering of albumen paper can be avoided only by care.

Blisters. Round elevations forming in faulty photographic printing papers, usually caused by unequal expansion. In albumen paper they generally appear during immersion in the fixing-bath. If they burst in drying, they cause spots. They occur only in strongly sized, freshly and heavily albumenized papers.

Blitzlicht. Flash-light, magnesium flash-light. The lightning-like, momentary but actinically very powerful flash caused by igniting a mixture of magnesium powder and chlorate of potash, or sulphide of antimony. Serves as light-source for instantaneous exposures at night or in dark places. If pure magnesium, without admixture, is employed, blowing it, by means of a mechanical arrangement, through the flame of a candle or spirit-lamp, etc., it is called a "Pustlicht" (blow-light). The pure magnesium powder burns more slowly than the explosive mixture.

Blow-Pipe. Used for the magic-lantern or for illuminating purposes by the use of the oxy-hydrogen light. With this jet, no

FIG. 31.



matter how suddenly the oxygen may be let on, or off, there is no snap. *O*, oxygen pipe; *L*, lime; *H'*, hydrogen pipe; *LP*, nut binding jet to stand; *SS*, plate allowing end of jet to tip up or down in centreing; *H*, hydrogen, *I*, oxygen inlet. Other forms are in use.

Blue Glass. Glass stained of a bluish tint. It is an excellent remedy against the non-photogenic effect of a yellow, hazy atmosphere. The Bohemian glass is the best, as it is more clear and even in tint. It may be used in the skylight, or placed in front of the lenses in the camera tube. It has been proved by actual experiment that the glass decomposes light, throwing off all colored rays and admitting white light only. This white light possesses all the actinic properties necessary for photography; therefore, by interposing blue glass between the model and the light of day uniformity of strength, and consequently time of exposure is obtained. An old method, out of use.

Blue Printing Process. (See *Cyanotype*.)

Blue Process. A means of duplicating drawings, plans, maps, documents, etc., by means of light-sensitive paper, without the use of a photo negative, directly exposing such paper under the drawings in the printing frame. Silver-, chrome-, and iron-salts serve as sensitizers, iron predominating. The resulting pictures are either in white lines on blue ground, or blue lines on white ground. The blue lines may, by subsequent treatment with gallic acid, be changed to black.

Blues. A term signifying solarization; it is caused by too long an exposure of the plate in the camera; and sometimes, in the daguerrotype, by moisture in the iodine box. The remedy for the latter is to coat the plate before using, or to keep the box over a heater.

Boiled Emulsion. Gelatine bromide of silver emulsion made highly sensitive by boiling for fifteen to twenty minutes.

Book Camera. A detective camera appearing outwardly like a book.

Books on Photography. A complete list of the standard text-books in all departments of photographic work can be found in the BIBLIOGRAPHIC SUPPLEMENT given at the end of this book.

Boracic Acid. This acid is formed of 16 equivalents of the metal boron and 24 of oxygen, and may be obtained by borax or the biborate of soda in boiling water, and then adding very dilute sulphuric acid until the mixture becomes sour; the sulphuric acid combines with the soda and sets at liberty the boracic acid, which crystallizes by evaporation in thin scales of a shining appearance. It has a bitter taste, is soluble in water and alcohol, is sour, reddens vegetable blues, and turns turmeric paper brown. It is used in the iron developer for positives to produce a white silver deposit.

Borax. Syn., sodium biborate. It is found native in a crude state in the saline marshes of Nevada and California, but is also manufactured by boiling boric acid (crude) with sodium carbonate. Commercially it appears as a white powder, soluble in hot and cold water, with an alkaline reaction.

Borax has many uses in photography. It is used as a flux in converting residues of the precious metals, in ceramic photography, and as a means of obtaining an aqueous solution of shellac as a varnish for prints, etc. It may be used in development with

eikonogen in place of sodium carbonate, the following being a good formula:

Eikonogen	1 part.
Sodium Sulphite	2 parts.
Borax	2 "
Water	100 "

Although normally possessing an alkaline reaction, borax acts as a retarder with the pyrogallol and catechol developers; while added to quinol, resorcin, hydroxylamine, or eikonogen, it acts as an accelerator.

Added to the fixing-bath for albumen prints, in the proportion of 1 ounce of borax to 1 pound of hypo. soda, and 1 gallon of water, borax is said to be an excellent remedy for blistering.

The use of borax as an addition to the toning-bath for albumen and Aristotype prints is well known. Prof. E. Vogel gives the following as a good borax bath:

1. Borax	116 grains.
Distilled Water	35 ounces.
2. Chloride of Gold	15 grains.
Distilled Water	1½ ounces.

For use, mix 7 ounces of No. 1 with 50 minims of No. 2 for each sheet of paper to be toned.

Brenzcatechin. (See *Catechol.*)

Brilliancy. An expression applied to negatives perfect in every respect, and which give faultless prints.

Brilliant Albumen Paper. Doubly albumenized paper—photographic raw paper which, by double coating with albumen, has received a high gloss.

Bringing Out the Picture. A term applied to the mercurialization of the daguerrotype plate, and the submission of the paper, or glass negative, or ambrotype, to the developing agent. The process for developing glass and paper photographs is described under their proper heads.

Broken Negatives may be repaired as follows: If the gelatine film is not broken, remove it from its support as described under stripping films (q. v.) and remount. If, however, the film is broken, bind the broken parts carefully together at the edges with thin strips of strongly gummed paper, and then set the negative on a level table and varnish both sides, by which procedure it is materially strengthened. Another excellent method is to apply Canada balsam to the edges of the broken parts and press them neatly together, having the negative on a glass plate during the operation. Then flow the film with varnish, and apply a clean cover-glass of thin crystal. When this is dry, turn the two over and repeat the varnishing on the glass side of the negative, again applying a third cover-glass. When dry the three plates should be bound together with strips like a lantern-slide.

Broken negatives may be printed from without showing the cracks, by causing the printing-frame to constantly revolve during printing (attached to a meat-jack), or by printing at the bottom of a box, 18 inches deep, with open top.

Bromic Acid. A compound prepared by the action of any pure alkali, or earth, on separate portions of bromine, containing 1 part of bromine and 5 of oxygen. Add sulphuric acid to a solution of bromate of baryta until all the earth is thrown down, particularly avoiding an excess of acid; then concentrate the liquor by heat, until it becomes of the consistence of syrup. Bromic acid is very sour, has very little odor, and reddens litmus paper at first, but afterward destroys the color. It unites with the alkalies and forms bromates.

Bromide of Aluminium. A salt prepared by saturating hydrobromic acid with gelatinous alumina and carefully evaporating to dryness. Used with good effect in sensitizing collodion, 1 grain to the ounce.

Bromide of Ammonium. This may be obtained by the mixture of ammonia and hydrobromic acid and liquor of ammonia; or by putting bromine into water of ammonia. By evaporation it forms solid prismatic crystals, very volatile and easily decomposed. The solution of this compound, in the proportion of 1 part of bromide of ammonium to 1 of distilled water, is an excellent fixative for positive proofs. The proofs must be left in the bath one hour and a half, and then washed in several waters. Bromide of ammonium is employed in the preparation of both negative and positive papers. For this purpose it is prepared as follows:

Water	1 ounce.
Iodide of Potassium	15 grains.
Bromide of Ammonium	4 "
Sugar of Milk	40 "

It also gives great sensitiveness to collodion when added in the proportion of 1 grain to the ounce of iodized solution, and in the preparation of gelatine emulsion. With iron and pyro it counteracts fog and acts as a developer.

Bromide of Arsenic. This is a good intensifier of collodion. To 1 ounce of iodized collodion add 1 drop of a saturated alcoholic solution of this salt; it first becomes turbid, but clears up after standing a few hours; it must not be used, therefore, immediately. Bromide of arsenic may be made by adding dry arsenic, in powder, cautiously and in small quantities at a time, to bromine, as long as light continues to be emitted; then distil into a cool receiver. When liquid it is yellow.

Bromide of Bismuth. This salt is prepared by heating the metal with an excess of bromine in a glass tube, when a gray-colored mass, resembling fused iodine, is formed. It is volatile, and decomposed by water.

Bromide of Cadmium. A whitish, volatile salt made by the union of hydrobromic acid and cadmium in the same manner as for bromide of aluminium. Added to iodized collodion, 1 or 2 grains to the ounce, to increase its intensity and sensitiveness.

Bromide of Calcium. CaBr. A white deliquescent salt, very soluble in water; sometimes used in collodion and sensitive paper.

Bromide of Carbon. It is prepared by mixing 2 parts of bromine with 1 part of periodide of carbon, and adding just sufficient potassa in solution to make the liberated iodine disappear. The liquid bromide of carbon collects at the bottom of the solution, and is separated from the supernatant portion and allowed to stand until it becomes clear. A few crystals of iodide of potassium rise to the surface, which are to be removed. The clear liquid is then put into a little water, slightly alkalized with potassa, to remove a little remaining iodide of carbon, after which it is quite pure.

Bromide of Copper. (See *Cupric Bromide.*)

Bromide of Iodine. An excellent photographic accelerator. Bromine and iodine unite rapidly by mere mixture.

Bromide of Lead. A salt sometimes used in sensitizing collodion; 1 grain of the salt to 1 ounce of iodized collodion. Bromide of lead is a white, crystalline powder, sparingly soluble in water, formed by precipitating a neutral solution of acetate of lead with a solution of bromide of potassium. It fuses, by heat, into a red liquid which turns yellow when cold.

Bromide of Lime. This is one of the best sensitives used for the daguerrotype.

Bromide of Lithium. A salt formed by dissolving lithium in hydrobromic acid and evaporating to dryness. Used for sensitizing collodion in the same manner, and in the same proportions as other bromides.

Bromide of Mercury. Is a white, insoluble powder, obtained by precipitating a solution of protonitrate of mercury by bromide of potassium. The bi-bromide of mercury is formed by dissolving peroxide of mercury in hydrobromic acid.

Bromide of Nickel. This salt may be prepared in the same manner as bromide of lithium, and used for sensitizing collodion in the usual way.

Bromide of Potassium. KBr. Colorless, square crystals, easily soluble in water. This salt is prepared by pouring an aqueous solution of potash into an ethereal solution of bromine until the ether is rendered colorless. In its pure state it is the best bromide salt for obtaining bromide of silver. It is used in developers and gelatine emulsions, and is analogous to bromide of ammonium. By mixing the bromide of potassium with chloride of sodium, in preparing the positive paper, proofs of a grayish-black color, of very pleasing effects, are obtained. It is used in the following combination:

Distilled Water	6 parts.
Bromide of Potassium	1 part.
Chloride of Sodium	1 "

Bromide of potassium enters largely into the photographic processes as a wash for paper and for sensitizing collodion, from 1 to 2 grains of the salt being used to the ounce of iodized collodion. It is also used for fixing photographs, but it is not so good as hyposulphite of soda for the latter purpose.

Bromide of Silver. Is formed by adding a solution of bromate of potassa to another of nitrate of silver, and crystallizing. By applying heat to the compound, oxygen is evolved and the mixture becomes bromide of silver. This salt, like the iodide, does not appear to be very readily changed by the solar rays, when perfectly pure. The slightest admixture of nitrate of silver renders it very susceptible of change, and under certain conditions it becomes the most sensitive of the photographic preparations. Yellow in color, it changes to violet-gray if exposed to light, as it resolves itself into

bromide and silver sub-bromide. It is insoluble in water, somewhat so in ammonia, and is soluble in hyposulphite of soda and cyanide of potassium.

Bromide of Sodium. NaBr. Prepared similarly to potassium bromide; occurs in small white crystals; soluble in water and alcohol. It is said that the use of this salt in the preparation of gelatine emulsions renders them more sensitive to orange and yellow rays than if potassium or ammonium bromide is used.

Bromide of Zinc. Prepared by digesting zinc filings in hydrobromic acid over a sand bath; filter, wash in a little water, and evaporate to dryness. Used for giving increased sensitiveness to iodized collodion.

Bromide Paper. Paper coated with silver bromide and gelatine in emulsion—similar to that used in the manufacture of gelatine dry plates—may be used for enlargements and contact-printing. Paper thus prepared may be obtained commercially, of different grades as to surface texture, and of varying rapidity—slow, rapid, etc. Formulæ for the preparation of such paper can be found under *Emulsion* (q. v.), but the commercial article is so convenient and reliable that it is generally used in preference to home-made paper. Formulæ for the development and fixing of the various commercial papers are given by the manufacturers. For contact-printing on gelatino-bromide paper negatives known as "plucky" in character give the best results. The convenience of bromide paper for enlarging purposes consists in the fact that in its use no enlarged negative is essential, the enlargement being made direct upon the paper, which is afterward developed and fixed, generally with ferrous oxalate. Bromide prints withstand all the usual tests for permanence, and if carefully made should be as permanent as gelatine negatives. Absolute cleanliness is essential in the treatment of gelatino-bromide papers, and the fingers must be scrupulously clean or stains will result. Blisters may be avoided by passing the prints through a solution of common salt after fixing and before washing. When fixed the prints should be well washed with abundant water for two hours and then hung up to dry. These prints are mounted, in a dry state, with strong adhesive; those on smooth paper may be burnished if desirable, while the rougher surfaces admit of any amount of after-working with crayon or brush. During the past year or two the toning of bromide prints has received much attention. E. J. Wall has compiled a very complete table of solutions adapted to the obtaining of various tones after this manner, which is given herewith:

The bromide print may be developed with ferrous oxalate, quinol, or eikonogen, but in no case must full vigor be obtained; in fact, the finest results are to be secured by over-exposure and thin images obtained with eikonogen; after fixing and well washing immerse the print in the well-known lead intensifier of Eder and Toth, which is composed of

Nitrate of Lead	4 parts.
Ferrocyanide of Potassium . .	6 "
Distilled Water	100 "

Filter.

The image becomes white from formation of the ferrocyanides of silver and lead, and this enables us to obtain almost any color we like. For convenience I now tabulate the tones and the necessary solutions.

Black, by using

Ammonium Sulph-hydrate . .	1 part.
Distilled Water	3 parts.

Brown, by using

Schlippe's Salt	10 parts.
Ammonia	5 "
Water	150 "

Reddish yellow, by using

Potassium Bichromate . . .	1 part.
Ammonia	1 "
Water	10 parts.

Yellow, by using

Neutral Chromate of Potash . .	1 part.
Water	10 parts.

Green, by treating the yellow image with

Ferric Chloride	1 part.
Water	10 parts.

Brown, by treating the yellow image with

Permanganate of Potash . . .	1 part.
Water	10 parts.

Copper-red (Bartolozzi), by treating the yellow image with

Cupric Chloride	1 part.
Water	10 parts.

Red-brown, by treating the image with

Nitrate of Uranium	1 part.
Ammonium Chloride	1 "
Water	10 parts.

Deep yellow, by treating the yellow image with

Iodide of Potassium	1 part.
Water	10 parts.

Reddish-brown, by treating the white image with

Copper Sulphate	1 part.
Water	10 parts.

Green or reddish-gray, by treating the white image with

Cobalt Chloride or Sulphate	1 part.
Water	10 parts.

This image is first greenish and then gradually turns reddish gray.

Green, by treating the white image with

Nickel Chloride or Sulphate	1 part.
Water	10 parts.

Orange-yellow, by treating the white image with

Mercuric Chloride	30 parts.
Potassium Iodide	45 "
Water	100 "

Sepia tones on bromide paper may be obtained by developing with the following formula:

A. Water	1000 parts.
Potassium Oxalate	330 "
B. Water	1000 parts.
Potassium Chloride	130 "
C Water	500 parts.
Ferrous Sulphate	24 "
Citric Acid	2 "
Potassium Bromide	2 "

To develop, mix of

Solution A.	20 parts.
Solution B.	5 "
Solution C.	5 "

The brown tone is more pronounced by increasing the quantity of B.

Platinum Toning.—Vidal advises that bromide prints may be toned in platinum with the formula:

Water	2000 parts.
Bichloride of Platinum	1 part.
Hydrochloric Acid	25 parts.

An exhaustive treatise upon *Bromide Paper* by Dr. E. Just is the most comprehensive manual on this subject.

Bromine. Is a simple substance, and was discovered by M. Balard, of Montpelier, in 1826. It is prepared by passing a current of chlorine through the liquid which remains after the evaporation of sea water to obtain common salt. It is a dark brown-red, very volatile liquid, giving off fumes of offensive smell. It is kept stored under water. It is of importance for photography in its combinations with metals. Its aqueous solution was used for fuming daguerrotypes.

Bromo-Iodide of Lime. A name given to a preparation of lime with bromine and iodine.

Bromo-Iodide of Silver. This name has been given to the compound formed by acting upon metallic silver with the vapors of iodine and bromine successively; also to the mixed salt obtained by decomposing bromide and iodide of potassium, in the proper atomic proportions, by nitrate of silver. This salt forms the true photogenic sensitive surface in all successful photographic operations.

Bromo-Iodized Bitumen. A compound invented and patented by Mr. V. M. Griswold, of Ohio. Dilute asphaltum varnish (which has been prepared by boiling one-half gallon linseed oil, 1 pint Japan varnish, and 5 or 6 ounces asphaltum, to such a consistence that it will, when cool, roll into a hard ball) to a proper consistence with spirits of turpentine; add to 8 ounces turpentine ½ ounce bromine and 1 ounce iodine, a small quantity at a time, as they unite with great heat, and must be managed with care. When thoroughly united this is bromo-iodized turpentine, which, added to a half-gallon of the prepared bitumen forms the *bromo-iodized bitumen.*

Bronze Positives. Beautiful pictures in bronze powders of various colors may be obtained on glass or ferrotype plates, aluminium, etc., by the subjoined process of Veress, the well-known experimenter in heliochromy. The sensitive compound is made as follows:

Distilled Water	100 parts.
Cane Sugar	2 "
Glucose	5 "
Gum-arabic (powdered)	5 "
Honey	1 part.

After the ingredients are dissolved, 10 parts of a saturated solution of bichromate of ammonia are added; the mixture is allowed to stand for some hours, and then thrice filtered. With this solution the plates are

coated. It is important to obtain an entirely uniform layer, and to keep the solution and prepared plates free from dust. Dry the plates near the fire; after five to fifteen minutes they will be dry, and may then at once be exposed in the printing-frame under a negative in diffused light. The time of exposure depends very much upon the moisture of the air; give at first a trial exposure —say of ten minutes. It is better to expose a little too long than too short. To develop, a tuft of cotton is charged with bronze powder and passed lightly over the surface of the plate. This manipulation, as well as the coating, may be effected in a room in weak daylight. When the image is fully developed, a second clean tuft of cotton is taken, and the surface of the plate brushed over with it until the bronze image begins to become bright, and the deepest shadows are entirely free from bronze powder. Splendid effects may be obtained if differently colored powder is used in development. After the image has been completely developed, coat with 2 per cent. of collodion to which some glycerine has been added. The plate should then be exposed to sunlight; if it be a glass plate it is exposed from behind, through the glass. After from fifteen to twenty minutes the plate is washed in running water until the yellow color has been removed and the water remains clear. After drying, the surface is varnished with diluted copal varnish, or with colorless Japan varnish in the case of the support being a metal plate; the glass plates, however, are coated with a dark-brown or black varnish, and looked at from the glass side.

Bronzed Shadows. The deepest shadows of a positive picture, which, in consequence of ample printing under a very strong negative, receive a bronzed appearance, which disappears again usually in the toning and fixing.

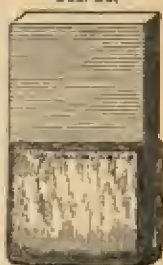
Brooke's Photographic Self-Registering Magnetic and Meteorological Apparatus. The importance of instruments whereby the direction and intensity of the earth's magnetism may be readily ascertained, is acknowledged by all scientific men; and the application of photography to this purpose is a means whereby much labor has been saved in meteorological observations.

Browning. A term applied to photographs and paper which have turned brown by keeping or other causes, after sensitizing; commencing before and continuing after printing. Pictures printed on such papers, examined by transparency, look dull and granular in the whites, and are usually destroyed as worthless. Mr. Lyte has succeeded in discovering a formula which obviates this difficulty. When a batch of proofs have been printed, washed, and dried, they should be sorted over, and the browned ones treated with the following bath:

Solution of Perchloride of Iron	1 fluidounce.
Strong Hydrochloric Acid . .	2 fluidounces.
Nitric Acid	½ fluidounce.
Water	3 quarts.

Plunge the proofs into this solution, keeping them moving all the time, and they will rapidly bleach in the white parts. As soon as the desired result is obtained they should be removed from the bath, and having been washed in pure water, passed into a weak hyposulphite of soda bath of not more than 4 or 5 per cent. The subsequent washing to get rid of the hyposulphite is afterward to be proceeded with as usual. In order to insure the complete abstraction of all the acid from the paper before placing it in the bath of hyposulphite of soda, enough finely powdered chalk or whiting to produce milkiness may be mixed up with the last washing-water; but the picture should be passed through two or three waters at least beforehand, so as to get rid, as far as possible, of all the iron salts. As the bath acts on the whole picture, the brown sheets, if intended to be thus treated, should be overprinted.

FIG. 32.



Brushes in Photography. *Blanchard's Brush*, used for hastening the flow of solutions on canvas and other material, and for coating plates in some of the wet processes. It is made by doubling and fastening a piece of swan's-down calico around a strip of glass, 2 inches wide and 6 inches long, with a rubber band.

Buckle's Brush is used for spreading emulsions and solutions. It is a convenient substitute for the camel's-hair brush, and can be renewed as frequently as desired. It is made by drawing, with a piece of bent silver wire, a tuft of absorbent cotton within the

end of a glass tube which serves as a handle, the projecting portion of the cotton forming the brush.

Mounting Brush, for rubbing mountant on the print or mount, should preferably be stiff and not too long in the hair. A good hog's-hair shaving brush answers the purpose admirably. A flat brush is better.

Development Brush, for use in local acceleration or retardation during the development of a negative; should be what may be bought as a gilder's mop, of camel's-hair mounted in quill, without metal about it.

Brushing. The act of laying on sensitive solutions to paper with a brush or pellet of cotton. To do this in the best manner lay the paper upon a flat board slightly smaller than the paper, and tack or pin the right and left angles farthest from you to the board. Pour sufficient solution to cover the paper upon the centre of the sheet, and with your pellet of cotton or brush spread it carefully by a circular motion outward toward the edges, going over it three or four times; then pass your brush backward and forward lengthwise over the whole surface, then crosswise, repeating these movements until the solution is well absorbed by the paper, and looks even and glossy. When thoroughly and nicely done there will be no dripping when the sheet is hung up to dry. Do not press your brush against the paper so heavily as to rough up the surface.

Bubbles. Highly persistent soap-bubbles, useful for the study of the phenomena relating to thin laminæ and for bubble photographs, may be obtained by the use of a resinous soap made as follows: Pulverize together 10 parts of pure resin and 10 parts of carbonate of potash; add 100 parts of water, and boil until complete solution ensues. This thick stock solution is diluted for use with four or five times its volume of water, and used in the usual manner.

Buff. The instrument used for polishing the daguerrean plate by hand. It is made of silk velvet plush, velveteen, or buckskin, the latter being decidedly the best.

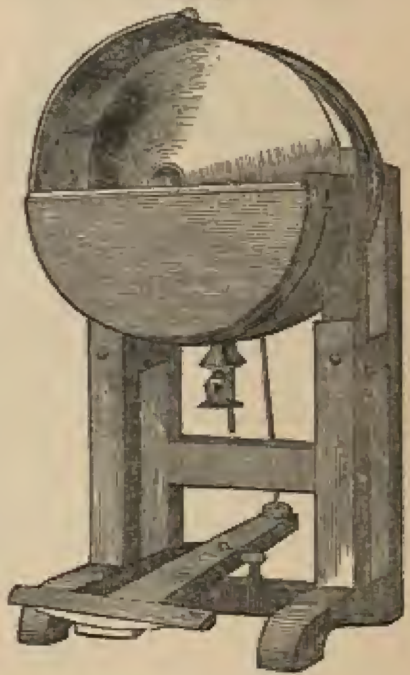
Buff Brush. A very useful article for keeping the buffs clean.

Buffing the Plate. This operation is one of the most important in daguerrean manipulation.

Buff Leather. The best material for this article is deer-skin. It should be well dressed and deprived entirely of grease or other extraneous matter, and soft and firm in the texture. A genuine deer-skin, when dressed, may be known by its exhibiting a vein-like appearance upon the flesh or yellow side.

Buff Wheel. A machine for polishing the plate in galleries where great numbers of daguerrotypes are daily taken, as it is more expeditious and thorough than the hand buff above described. An old helper. (Fig. 33.)

Fig. 33.



Bunsen Burner. A gas-fixture in which illuminating gas mixed with air is burned, giving a blue flame of great heat but little light power.

Burette. A graduate glass for measuring liquids.

Burgundy Pitch. Is the resin of the *Pinus abies.*

Burning Fluid. Is a solution of turpentine in alcohol. Turpentine, 2 parts; alcohol, 1 part.

Burnish. The highly polished or brilliant surface imparted to photographic prints by the use of the heated burnisher.

Burnisher. A machine for imparting a high polish to the surface of photographs by a draw process rather than by pressure. The method might be called ironing, as heat is applied to the burnisher from below.

FIG. 34.

Burnishing. Imparting a highly polished or brilliant surface to photographic prints by means of a heated burnisher.

Burnt-in or Ceramic Photographs. Photographs transferred to porcelain, glass, or enamel, and burnt-in on these supports in a muffle. Imperishable. The original process of the inventor is as follows:

The plate of glass or porcelain, or other substance, on which the picture is to be produced may be glazed prior to the application of the sensitive mixture, or this glaze or flux may be carried over the finished picture before burning. The first preparation of the plates, after cleaning, consists in the application of the following mixture. Make separate solutions of gum arabic and gelatine:

Gum Arabic	72 grains.
Sat. sol. Bichromate of Potash	½ ounce.

Dissolve without heat.

Gelatine	15 grains.
Water	1 ounce.
Sat. sol. Bichromate	1 drachm.

Dissolve in water bath. When cool, add the solution of bichromate. Shake well and filter. Take of the solution of

Gum Arabic	11 parts.
Gelatine	5 "
Water (distilled)	5 "

To every drachm of this mixture add 9 or 10 drops of honey syrup formed by mixing equal parts by volume of honey and water, and filtering, after heating gently over a water bath and shaking it well. The plate on which the picture is to be produced must be warmed and a sufficient quantity of the mixture poured on in the same manner as collodion, drained off, and gradually dried. The film must be very even. A vigorous positive picture is then laid on in the usual manner and exposed to the sunlight for from six to ten minutes, when a good negative impression should be visible. By the light of a lamp, produce the positive picture. This is effected by carrying over the surface of the plate any finely powdered color by means of a cotton pad. Its successful application requires some experience. The surface of the plate should be beaten gently and equally—not rubbed. The cotton should be occasionally breathed on and re-charged with color. The color will be found gradually to adhere to the unsunned parts of the film, and its application should be continued until the picture is considered sufficiently powerful. Almost any amount of vigor may be obtained. To remove the sensitive coating unchanged by the light, apply alcohol and dilute nitric acid, 1 drachm of the former to 6 drops of the latter, either by pouring it on or plunging the plate in a bath. While pouring on and off the plate, evaporation of the alcohol takes place, therefore care must be taken to keep up the proportion by adding a little pure alcohol occasionally. When the brown color of the changed bichromate disappears, the acid spirit must be poured off, and pure alcohol poured on and off once or twice, using fresh quantities each time, it being necessary to remove every trace of the acid and water.

The picture must be dried very rapidly and is now ready for burning, provided the plate has been previously covered with the flux; if not, apply it in the following manner: Pour on a solution of Canada balsam in turpentine; dry by heat until every trace of the turpentine is evaporated; then apply the flux equally and evenly with a cotton pad. The flux may consist of borax and glass, or borax, glass, and lead ground together with water on a glass slab and dried. The plate can now be placed in a hot oven, or into a fire between two pieces of flat iron and suffered to remain until the flux is set; then taken out and cooled. An ordinary collodion positive may be covered with a flux and burnt. (See *Enamel Photographs*, *Watch-Dial Portraits*, etc.)

Burnt. (See *Solarization.*)

Burton's Combined Bath. (See *Combined Baths.*)

Bust Picture. A photographic portrait in which only the head and part of the bust is taken.

Button Lac. Shellac cast in sticks is known by this name.

Butyric Glucose. This is a neutral, oleaginous, yellow liquid, soluble in ether and aqueous alcohol, and slightly so in water. Submitted to the action of heat, it is decomposed and consumes without leaving any ashes. It reduces the cupropotassic tartrate, and becomes colored when mixed with sulphuric acid. Treated with warm dilute sulphuric acid, it is resolved into butyric acid and a fermentable glucose; at the same time a little ulmic matter is produced. *Cotton* and *paper* treated with a mixture of butyric and sulphuric acids yield a neutral compound analogous with butyric glucose.

C.

Cabinet. Designation of a photograph of certain dimensions. Also called "Imperial Card."

Cadmium. A soft, very pliable metal, of shining bright tin-white color. Used for restoring old red iodized collodion.

Calcium-Saccharate Developer. Pyro or hydroquinone developer, which, instead of ammonia or carbonate of soda, contains calcium saccharate.

Calomel. Subchloride of mercury, Hg_2Cl_2. Rhombic prisms, nearly insoluble in water, alcohol, and ether, evaporated by heat to complete sublimation.

Calorific Rays. The invisible, heating rays which emanate from the sun and from burning and heated bodies. They produce heat and expansion, but not color or vision.

Calotype. The name applied by Mr. Fox Talbot to the photographic process on paper, discovered by him in 1841. Because of its historical interest, full details of the original process are given. To produce a calotype picture there are five distinct processes, all of which, except the third, must be performed by candle-light; they are all very simple, but, at the same time, they all require care and caution. The first and not the least important is—

1. *Iodizing the Paper.* Much depends upon the paper selected for the purpose; it must be of a compact and uniform texture, smooth and transparent, and of not less than medium thickness. Having selected a sheet without flaw or water-mark, and free from even the minutest black specks, the object is to spread over its surface a perfectly uniform coating of the iodide of silver by the mutual decomposition of two salts, nitrate of silver and iodide of potassium. There is a considerable latitude in the degree of dilution in which these salts may be used, and also in the manner and order of their application; but as the thickness and regularity of the coating depend upon the solution of nitrate of silver, and upon the manner in which it is applied first, before the surface of the paper is disturbed, I use a solution of the strength of 17 grains to the ounce of distilled water. The paper may be pinned by its two upper corners to a clean dry board a little larger than itself; and, holding this nearly upright in the left hand and commencing at the top, apply a wash of the nitrate of silver *thoroughly, evenly,* and *smoothly,* with a large soft brush, taking care that every part of the surface is thoroughly wetted, and that nothing remains unabsorbed in the nature of free or running solution. Let the paper now hang loose from the board into the air to dry, and by using several boards time will be saved. The nitrate of silver spread upon the paper is now to be saturated with iodine, by bringing it in contact with a solution of the iodide of potassium; the iodide goes to the silver, and the nitric acid to the potash. Take a solution of the iodide of potassium of the strength of 400 grains to a pint of water, to which it is an improvement, analogous to that of M. Claudet in the daguerrotype, to add 100 grains of common salt. He found that the chlorinated iodide of silver is infinitely more sensitive than the simple iodide; and by this addition of common salt, a similar, though a less remarkable, modification is obtained of the sensitive compound. Pour the solution into a shallow flat-bottomed dish, sufficiently large to admit the paper, and let the bottom of the vessel be covered to the depth of an eighth of an inch. The prepared side of the paper having been previously marked, is to be brought in contact with the surface of the solution, and, as it is desirable to keep the other side clean and dry, it will be found convenient, before putting it in the iodide, to fold upward a

narrow margin along the two opposite edges. Holding by the upturned margin, the paper is to be gently drawn along the surface of the liquid until its lower face be thoroughly wetted on every part; it will become plastic, and in that state may be suffered to repose for a few moments in contact with the liquid; it ought not, however, to be exposed in the iodine dish for more than a minute altogether, as the new compound, just formed upon the paper, upon further exposure would gradually be re-dissolved. The paper is therefore to be removed, and, after dripping, it may be placed upon any clean surface with the wet side uppermost until about half dry, by which time the iodine solution will have thoroughly penetrated the paper, and have found out and saturated every particle of the silver, which it is quite indispensable it should do, as the smallest portion of undecomposed nitrate of silver would become a black stain in a subsequent part of the process. The paper is now covered with a coating of the iodide of silver; but it is also covered, and indeed saturated, with saltpetre and the iodide of potassium, both of which it is indispensable should be completely removed. To effect the removal of these salts it is by no means sufficient to "dip the paper in water;" neither is it a good plan to wash the paper with any considerable motion, as the iodide of silver, having but little adhesion to it, is apt to be washed off. But the margin of the paper being still upturned, and the unprepared side of it kept dry, it will be found that by setting it afloat on a dish of clean water, and allowing it to remain for five or ten minutes, drawing it gently now and then along the surface to assist in removing the soluble salts, these will separate by their own gravity, and (the iodide of silver being insoluble in water) nothing will remain upon the paper but a beautifully perfect coating of the kind required. The paper is now to be dried; but while wet do not on any account touch or disturb the prepared surface with blotting-paper, or with anything else. Let it merely be suspended in the air, and in the absence of a better expedient, it may be pinned across a string by one of its corners. When dry, it may be smoothed by pressure. It is now "iodized" and ready for use, and in this state it will keep for any length of time if protected from the light. The second process is that of exciting, or—

2. *Preparing the Paper for the Camera.* For this purpose are required the two solutions described by Mr. Talbot; namely, a saturated solution of crystallized gallic acid in cold distilled water, and a solution of the nitrate of silver of the strength of 50 grains to the ounce of distilled water, to which is added one-sixth part of its volume of glacial acetic acid. For many purposes these solutions are unnecessarily strong, and, unless skilfully handled, they are apt to stain or embrown the paper; where extreme sensitiveness, therefore, is not required, they may with advantage be diluted to half the strength, in which state they are more manageable and nearly as effective. The gallic acid solution will not keep for more than a few days, and only a small quantity, therefore, should be prepared at a time. When these solutions are about to be applied to the iodized paper they are to be mixed together, in equal volumes, by means of a graduated drachm tube. This mixture is called "the gallo-nitrate of silver." As it speedily changes, and will not keep for more than a few minutes, it must be used without delay, and it ought not to be prepared until the operator is quite ready to apply it. The application of this "gallo-nitrate" to the paper is a matter of some nicety. It will be found best to apply it in the following manner: Pour out the solution upon a clean slab of plate glass, diffusing it over the surface to a size corresponding to that of the paper. Holding the paper by a narrow upturned margin, the sensitive side is to be applied to the liquid upon the slab, and brought in contact with it by passing the fingers gently over the back of the paper, which must not be touched with the solution. As soon as the paper is *wetted* with the gallo-nitrate, it ought instantly to be removed into a dish of water; five or ten seconds at the most is as long as it is safe at this stage to leave the paper to be acted upon by the gallo-nitrate: in that space of time it absorbs sufficient to render it exquisitely sensitive. The excess of gallo-nitrate must be immediately washed off by drawing the paper gently several times under the surface of water, which must be perfectly clean; and being thus washed, it is finished by drawing it through fresh water, two or three times, once more. It is now to be dried in the dark, in the manner before described, and when surface dry it

may either be placed, while still damp, in the camera or in a portfolio, among blotting-paper, for use. If properly prepared, it will keep perfectly well for four-and-twenty hours at least, preserving all its whiteness and sensibility. The light of a single candle will not injure the paper at a moderate distance; but the less the paper, or the exciting solution, is unnecessarily exposed, even to a feeble candle-light, the better. Common river- or spring-water answers perfectly to *wash* the paper, distilled water being required for the silver solutions only. Stains of gallo-nitrate, while recent, may be removed from the fingers by a little strong ammonia, or by the cyanide of potassium.

3. *Exposure in the Camera*, for which, as the operator must be guided by his own judgment, few directions can be given, and few are required He must choose or design his own subject; he must determine upon the aperture to be used, and judge of the time required, which will vary from a few seconds to three or four minutes. The subject ought, if possible, to have a strong and decided effect; but extreme lights, or light-colored bodies, in masses, are by all means to be avoided. When the paper is taken from the camera, very little, or more commonly no trace whatever, of a picture is visible until it has been subjected to the fourth process.

4. *Bringing out the Picture* is effected by again applying the gallo-nitrate in the manner before directed. As soon as the paper is wetted all over, unless the picture appears immediately, it is to be exposed to the radiant heat from an iron, or any similar body, held within an inch or two by an assistant. It ought to be held vertically, as well as the paper; and the latter ought to be moved, so as to prevent any one part of it becoming dry before the rest. As soon as the picture is sufficiently drawn out, wash it immediately in clean water to remove the gallo-nitrate; it may then be placed in a dish by itself, *under* water, until you are ready to fix it. The most perfect pictures are those which "come out" before any part of the paper becomes dry, which they will do if sufficiently impressed in the camera. If the paper be allowed to dry before washing off the gallo-nitrate, the lights sink and become opaque; and if exposed in the dry state to heat, the paper will embrown; the drying, therefore, ought to be *retarded*, by wetting the back of the paper, or the picture may be brought out by the vapor from hot water, or, what is better, a horizontal jet of steam.

5. *Fixing the Picture*, which is accomplished by removing the sensitive matter from the paper. The picture, or as many of them as may be, is to be soaked in warm water, but not warmer than may be borne by the finger; this water is to be changed once or twice, and the pictures are then to be well drained, and either dried altogether, or pressed in clean and dry blotting-paper, to prepare them to imbibe a solution of the hyposulphite of soda, which may be made by dissolving an ounce of that salt in a quart (forty ounces) of water. Having poured a little of the solution into a flat dish, the pictures are to be introduced into it one by one; daylight will not now injure them; let them soak for two or three minutes, or even longer if strongly printed, turning and moving them occasionally. The remaining unreduced salts of silver are thus thoroughly dissolved, and may now, with the hyposulphite, be entirely removed by soaking in water and *pressing* in clean white blotting-paper alternately; but if time can be allowed, soaking in water alone will have the effect in twelve or twenty-four hours, according to the thickness of the paper. It is essential to the success of the fixing process that the paper be in the first place thoroughly penetrated by the hyposulphite, and the sensitive matter dissolved; and next, that the hyposulphite compounds be effectually removed. Unless these salts are completely removed they induce a destructive change upon the picture; they become opaque in the tissue of the paper, and entirely unfit it for use. Some paper is to be met with, containing traces of bleaching chlorides, which does not require any previous preparation; but in general it will be found necessary to prepare the paper by slightly impregnating it with a minute quantity of common salt. This may be done by dipping it in a solution in which the salt can barely be tasted, or of the strength of from thirty to forty grains to a pint of water. The paper, after being pressed in clean blotting-paper, has merely to be dried and smoothed, when it will be fit for use. The ammonia nitrate of silver is applied to the paper in the manner before described, and, when perfectly dry, the negative picture to

be copied is to be applied to it, with its face in contact with the sensitive side. The back of the negative picture being uppermost, they are to be pressed into close contact by means of a plate of glass, and thus secured they are to be exposed to the light of the sun and sky. The exposed parts of the sensitive paper will speedily change to lilac, slate-blue, deepening toward black; and the light, gradually penetrating through the semi-transparent negative picture, will imprint upon the sensitive paper beneath a *positive* impression. The negative picture, or matrix, being slightly tacked to the sensitive paper by two mere particles of wafer, the progress of the operation may from time to time be observed, and stopped at the moment when the picture is finished. It ought then, as soon as possible, to be soaked in warm water, and fixed in the manner already described. In these pictures there is a curious and beautiful variety in the tints of color they will occasionally assume, varying from a rich golden orange to purple and black. This effect depends in a great degree upon the paper itself, but it is modified considerably by the strength of the hyposulphite, the length of the time exposed to it, by the capacity of the paper to imbibe it, and partly, perhaps, by the nature of the light. Warm sepia-colored pictures may generally be obtained by drying the paper, by pressure, and making it imbibe the hyposulphite supplied in liberal quantity. The paper of "I. Whatman, Turkey Mill," seems to give pictures of the finest color, and, upon the whole, to answer best for the purpose. If the chemical agents employed be pure, the operator who keeps in view the *intention* of each separate process, and either adopting the manipulation recommended, or improving upon it from his own resources, may rely with confidence upon a satisfactory result. This calotype paper is so exceedingly sensitive to the influence of light that very beautiful photographic copies of lace, feathers, leaves, and such-like articles, may be made by the light of a common coal-gas flame, or an argand lamp.—*R. Hunt.*

Calotype Process on Waxed Paper. The most successful operator on waxed paper has been M. Le Gray, to whom we are indebted for this and several other improvements. In a useful work published by this photographer, he has entered into the question of the physical agencies which are active in producing the chemical changes on the various preparations employed. Throughout the essay he evidently labors under an entire misconception of the whole phenomena, to which, indeed, it is clear he cannot have directed his attention. His manipulatory details are very perfect, but his scientific explanations are not to be received as correct expressions of the facts.

First Process: to wax the paper. This process divides itself into several parts, waxing the paper being the first. A large plate of silvered copper, such as is employed for the daguerrotype, is obtained and placed upon a tripod, with a lamp underneath it, or upon a balneum mariæ. The sheet of paper is spread upon the silver plate, and a piece of pure white wax is passed to and fro upon it until, being melted by the heat, it is seen that the paper has uniformly absorbed the melted wax. When this has thoroughly taken place the paper is to be placed between some folds of blotting-paper, and an iron, moderately hot, being passed over it the bibulous paper removes any excess of wax, and we obtain a paper of perfect transparency.

Second Process: to prepare the negative paper. In a vessel of porcelain or earthenware capable of holding 5 pints and a quarter of distilled water, put about 4000 grains of rice, and allow them to steep until the grains are but slightly broken, so that the water contains only the glutinous portion. In a little less than a quart of the rice solution thus obtained dissolve:

Sugar of Milk	620 grains.
Iodide of Potassium . . .	225 "
Cyanide of Potassium . . .	12 "
Fluoride of Potassium . . .	7 "

The liquid, when filtered, will keep for a long time without alteration. When you wish to prepare the paper, some of this solution is put into a large dish, and the waxed paper, sheet by sheet, is plunged into it, one over the other, removing any air-bubbles that may form. Fifteen or twenty sheets being placed in the bath they are allowed to soak for half an hour, or an hour, according to the thickness of the paper. Turning over the whole mass, commence by removing the first sheet immersed, and hooking it up by one corner with a pin bent in the shape of the letter S, fix it on a line to dry, and remove the drop from the lower angle by a little bundle of blotting-paper. M. Le Gray then remarks that French and English paper

should never be mixed in the same bath, but prepared separately, as the "English paper contains a free acid which immediately precipitates an iodide of starch in the French papers and gives to them a violet tint." The paper being dry is to be preserved for use in a portfolio; even in this state it is not absolutely insensitive.

Third Process: to render the waxed paper sensitive. Make a solution of

Distilled Water	. . . .	2325 grains.
Crystallized Nitrate of Silver	.	77½ "

and when this is dissolved, add of

Crystallized Acetic Acid	. .	186 grains.

Papers prepared with this solution will keep well for a few days. M. Le Gray, however, recommends for his waxed paper and for portraits, that the quantity of nitrate of silver be increased to 155 grains; the paper must be used moist. The method of preparing these papers is to float upon a horizontal plate of glass either of the above solutions, and taking a piece of the iodized paper to carefully place it upon the fluid, taking great care that no air-bubbles interpose. The paper must remain a short time in contact with this sensitive fluid until chemical combination is effected. Four or five minutes are required for some papers, and eight or ten seconds are sufficient for other kinds. When a violet tint appears, they should be removed. For those papers which it is desirable to keep for some time, as during a journey, it is recommended that into one vessel of porcelain you put about five or six millimetres of the strong aceto-nitrate above described, and into another some distilled water; you plunge completely both sides of the waxed and iodized paper in the first fluid, and allow it to remain about four or five minutes; withdraw it, and plunge it immediately into the bath of distilled water, in which let it soak for not less than four minutes. When these papers are carefully dried they may be preserved for some time for use, and by lessening the dose of the nitrate of silver this period may be considerably prolonged. It will, of course, be understood by all who have followed the processes described up to this point, that the papers which are prepared for keeping are not those which are the most sensitive; hence it is necessary to expose such a much longer time in the camera than those prepared by the stronger solution of silver. The more sensitive variety, under ordinary circumstances of light, will require an exposure in the camera of about twenty seconds, the less sensitive demanding about ten or fifteen minutes, according to the circumstances of light.

Fourth Process: the development of the image. The picture is developed by the aid of gallic acid dissolved in distilled water. Le Gray finds the following to be the best proportions:

Distilled Water	. . . .	40 fluidounces.
Gallic Acid	. . . .	60 grains.

The paper to be plunged in this solution, and allowed to remain until it is fully developed. The time will vary from ten minutes to two hours or more, according to the intensity of the rays incident on the paper when in the camera. The development of the image is much accelerated by the addition of 15 or 20 drops of the aceto-nitrate of silver.

Fifth Process: fixing. It is found convenient often, when on a journey, to give a temporary fixedness to the pictures obtained, and to complete the process with the hyposulphite at any time on your return home. A wash of 360 grains of bromide of potassium to 2 quarts of water is the strength which should be employed. The process of fixing with hyposulphite consists, as in other preparations, simply in soaking the paper until the yellow tint of the iodide has disappeared. (See *Paper Negatives.*)

Cameo Press. A device for embossing or raising the surface of a photograph above the card-mount. It is the invention of Mr. E. D. Ormsby. It is made of maple wood, three-quarters of an inch thick. The raised centre for mounting is glued on. The top and bottom are hinged together. (See Fig. 35.)

Another device for the same purpose was invented by Mr. R. J. Chute. It is an ordinary copying press with heavy metal dies, as shown in Fig. 36.

Camera. A light-tight box, in which the objective picture, by means of a lens combination, is projected upon a ground-glass, and, by substitution, upon a sensitive film—in short, the photographic apparatus for exposures. It is made of many different forms or patterns, but always capable of extension, so as to move the ground-glass, and like-

wise the sensitive film, nearer or farther off, as the case may require.

FIG. 35.

The *Camera obscura* was the invention of Baptista Porta, of Padua. The word camera is now wholly used by photographers to denote this instrument. It is perfectly

FIG. 36.

defined as an apparatus representing an artificial eye, in which the images of external objects, received through a double convex glass, are exhibited distinctly, and in their negative colors, on a white surface placed on the focus of the glass within a darkened chamber.

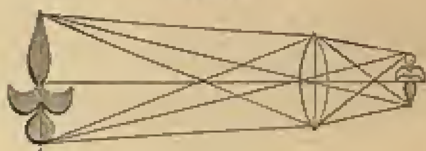
The act of vision is accomplished by means of a special organ or pair of organs, the eyes, which are partly physical, or, as we may say, instrumental in their action, officiating exactly as certain lifeless and inorganic structures, such as we artificially construct, would officiate in collecting and distributing the light rays; and partly physiological in their structure, calling into play those conditions of life about which we know but little, and which we can in no wise artificially reproduce, or by any amount of skill ourselves construct.

In the eye we have, in the first place, a lens capable, like our ordinary lenses, of forming an image upon the inner wall of the eye-cavity, or retina.

How then can a simple lens bring about such a result as the formation of an image?

The diagram shows this almost without need of further explanation. The rays from

FIG. 37.



the summit of the object, which, without the lens, would be scattered, are each differently bent by the different parts of the lens which they encounter, but so as to be united in a single point. The same thing happens for each other point of the object and its emitted rays, and the result is the production of an image, as is shown. This image, moreover, is inverted. How this comes can be seen by a mere glance at the diagram.

As in the phenomena of vision, so in the camera obscura, the image is produced by the radiations of light proceeding from the external object, and as these radiations progress from various parts, more or less illuminated, so are the high lights, the middle tints, and shadows most beautifully preserved in the spectral image. The colors, also, being in the first instance the effect of some physical modification of the primary cause, are repeated under the same influence; and the definition, the color, and soft grada-

tion of light and shadow are so perfect that few more beautiful optical effects can be produced than those of the camera obscura. Now, as every ray of light producing the colored image is accompanied by the chemical principle, *actinism*, and as this is regulated in action by the luminous intensity of the rays, the most luminous (*yellow*) giving the best chemical effect, which increases with the diminishing illuminating power of the radiating source, we have the impression made of every gradation according to the color of every object we would copy.

Camera, Binocular. This instrument differs from the common camera in having two lenses, with the same aperture and focal length, for taking at the same instant two pictures of a view or model. These lenses should be placed parallel to one another, and perpendicular to the horizon, at the distance of two and one-half inches apart. Binocular cameras are now constructed in a variety of styles, but the same rules for working the ordinary camera will apply to one as well as to the other. (See *Stereoscope and Stereoscopic Camera*.)

Camera, Panoramic. An instrument for taking panoramic views, invented by M. Belhomme, of France. This is accomplished without using covered plates, by means of a mirror. The whole camera revolves around a pivot fixed under the axis of the objective on an immovable plane. Two small wheels facilitate this movement. In the part opposite the objective there are grooves under and above. The frame of the mirror is placed in a sort of car, so as to enable it to turn around the point, supported upon the plane by two wheels. The frame is kept in the grooves by two other wheels fixed to the interior part of the car, and a third placed on itself. Placed at one side (the right, for instance) of the groove, which is double the height of the car, the camera, in turning (to the right), forces the frame to advance in the opposite direction in such a way that the mirror presents, successively, every part of its surface to the narrow slit which gives passage to the luminous beams reflected by the objective. (See *Marcellus' Cycloramic Camera*.)

Camera, Stereoscope. The object of this instrument is to unite the transient pictures of groups of persons or landscapes as delineated in two dissimilar pictures on the ground-glass of a binocular camera. If we attach to the back of the camera a lenticular stereoscope, so that the two pictures on the ground-glass occupy the same place as its usual binocular slides, we shall see the group of figures in relief under every change of attitude, position, and expression. The two pictures may be formed in the air, or, more curiously still, upon a wreath of smoke. As the figures are necessarily inverted in the camera, they will remain inverted by the lenticular and every other instrument but the opera-glass stereoscope, which inverts the objects. By applying it, therefore, to the camera, we obtain an instrument by which the photographic artist can make experiments, and try the effect which will be produced by his pictures before he takes them. He can then select the best forms of groups of persons and of landscapes, and thus produce works of great interest and value.

Camera Box. The dark chamber to which the tube is attached, and which contains the spectrum, and receives its prepared plate or paper during its exposure to the light. The forms and styles of camera boxes are now very numerous and very perfect in construction, but to describe them all, or even one-half of them, would require more space than should be occupied in a work of this kind; we must therefore leave our readers to consult their own taste in their selection.

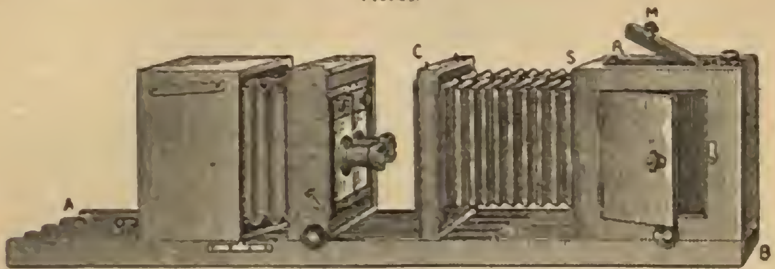
Camera Campertra. A camera of peculiar construction to work out of doors without the use of a tent. It was the invention of a Mr. Alfieri, and its use has been confined to England. We have seen no description of it.

Camera Chira. This is another instrument for out-door work without a tent. Besides possessing all the advantages of a dark tent, it allows a full view of the plate through all its changes, and the plate taken in or out at pleasure without injury. The lens is mounted on a new principle; it works in a ball and socket, and, like the pupil of the eye, has a range in all directions, the glass plate having a corresponding movement. Within the brass mountings and between the lenses are eight movable valves, to regulate the admission of light upon the sensitive plate. Four of these are colored white, blue, red, and orange; three are diaphragms of various apertures, and one is a cap valve, used when a very short exposure is required. This instrument contains within itself all the articles necessary for the negative pro-

cess—glass, bottles, dishes, etc—the whole so arranged that all may be taken and arranged for use and repacked in five minutes. This instrument was the invention of Mr. Frederick Fast, of England.

Camera for Stereoscopic Pictures on Glass. The invention of M. Donnadieu. It consists of a grooved slide, A, B, on one side of which the camera moves, which does not need any separation, but carries the two stereoscopic objectives. In front of this is another camera, whose part, C, is joined to a box, M, by two bellows, S and S′. These are prolonged into the interior of the box, M, by a wooden separation resting on the plate. The plate is placed at the top of the box, which is provided with a ground-glass. The board which slides before the glass serves as an obturator. Shutters placed on top and on each side of the box allow the plate to be put easily in the proper position in a frame furnished with two slides, allowing the displacement in the vertical and longitudinal direction. (Fig. 38.)

FIG. 38.



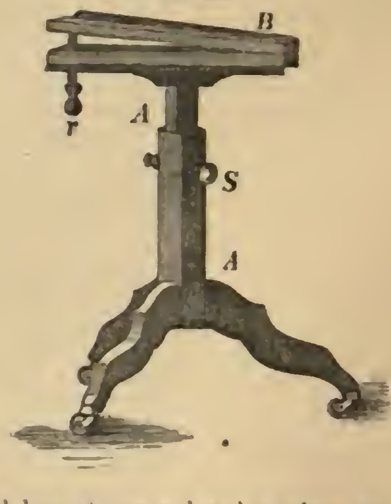
Camera Front. Front board; the little board which carries the objective.

Camera Lens. There are three kinds of lenses used in the photographic camera, viz.: a concavo-convex lens, a double convex, and meniscus. Several formulas for making these lenses are used by opticians; but in all cases they should be perfectly achromatic and free from blisters, striæ, or curved lines; the most injurious are those which, reunited in number, form a kind of whirl. It is also very necessary that the polish of the surface be very bright and exempt from what opticians call gray polish. They should always have a diameter conformable to the following principles: those which have the longest focus should have the greatest diameter, and the visual and chemical foci agree. (See *Focus, Focal Distance, Lens, etc.*)

Camera Lucida. An optical instrument, which, by means of a stylo, lenses, and chamber gives the outlines of external objects on paper or canvas, so that an artist can sketch the subject.

Camera-Negascopic. An instrument—the invention of Mr. Seely, of New York—for enlarging small negatives to any size positive photographs. It consists simply of the ordinary bellows camera box, with tube and lens at one end and a mirror at the other, with a sliding box between for the negative. The mirror is movable by means of cords passing to the opposite ends of the box within the dark-room.

FIG. 39.



Camera-Obscura. (See *Camera.*)

Camera Stand. Fig. 39 is one of many forms used by photographers in the studio. *A A* is a post, adjustable; *B*, the top; *r* is a wooden screw for raising and lowering the top, *B;* and *S* the screw for fastening the post when raised or lowered.

The styles of camera stands have become so numerous of late years that to enumerate them all would require the space of several pages; refer to dealers' catalogues.

Camera Tube. The brass case enclosing the lenses.

Camphene Wax-Paper Process. By using camphene, or benzine, as the solvent for wax, the impure portion is thrown down and the pure part only retained in solution. This constitutes the chief element of success in this process, as it obviates the granulated appearance which is the great drawback of the ordinary wax-paper. Saxe paper is the best for this purpose. The formulæ and various manipulations are as follows:

Camphene or Benzine Waxing Solution. Put 300 grains wax, scraped fine, and 20 fluidounces benzine or camphene into a quart bottle, and stand it before a fire, shaking occasionally, until the wax is dissolved. Set aside to cool, then add by degrees 80 grains iodine and agitate. Let the whole stand for a week, to allow any portion of the wax to precipitate; then filter through double paper. Pour sufficient of this liquid into a flat porcelain dish, scrupulously clean and dry; take one of the papers by opposite corners, and lay the marked side on the solution, first letting the middle of the sheet touch the liquid. Should any bubbles occur, raise up one corner of the paper with a pair of horn forceps till the bubble is arrived at, and then lower it again. When the paper is thoroughly saturated, immerse it, using a glass rod in the left hand and a glass triangle in the right. Pass the triangle over the paper and press it against the bottom of the dish, so as to remove air-bubbles from the surface of the sheet. Proceed with half a dozen sheets in this way; more than this number should not be in the dish at the same time. After letting them remain in the liquid five minutes, turn them all over together, so that the first put in will be uppermost. Take the horn forceps and raise this sheet by one corner, holding it over the dish to drip until it has nearly ceased. Then thrust a large pin through the upper angle and stick it into the edge of a shelf, so that the paper may be suspended with its lower corner resting on blotting-paper. When all the papers have been thus treated, proceed with six more; and when they have been hung up, take down the first six, and press them between clean blotting-paper and hang them up in another part of the room until quite dry. The waxing liquid will serve until all used up. Put the prepared papers away in a portfolio until required for iodizing, previous to which warm them slightly before a fire.

The Iodizing Solution. 320 grains iodide and 40 grains bromide of potassium dissolved in 20 fluidounces of whey. Filter, and after use return it into the stock bottle through filtering-paper. Immerse the papers, sheet by sheet, in this bath, and let them remain in about 20 minutes in warm, summer weather, half an hour in mild weather, and one hour in winter. Take each out separately, hold to drip, press between blotting-paper to be kept specially for the purpose, and hang up until quite dry. They will keep twelve months if not exposed to damp.

The Sensitizing Bath. Dissolve 400 grains of nitrate of silver in 9 ounces of water, and 4 grains iodide potassium in 1 ounce water; add the latter to the former, stirring with a glass rod until the precipitate is dissolved. Then add 5 grains citric acid, dissolved in 3 drachms crystallizable acetic acid, and filter through double paper. This bath must not be exposed to daylight. After use, return to the bottle through a filter. To sensitize the paper, float it on the solution, marked side downward, till the dark color disappears, then turn it over and float the other side until it has acquired a uniform primrose color. Raise it with the horn forceps, let it drip, and place it in a dish containing as much water as will cover it well; give the dish a rocking motion for half a minute, then, if the paper is intended for exposure next day, blot it off in a separate blotting book, and expose to dry. If wanted for longer keeping, give the papers a second washing in another water, blot off and dry. Sensitize by the light of one candle. When quite dry, they may be placed in the double back or dark slide for exposure. If put in damp they will crease. Extra papers should be put into a portfolio and subjected to pressure.

Exposure. The time of exposure is about the same as for collodio-albumen plates. Do not expose in a bad light and be sure not to under-expose.

Developing Solution. Put one drachm of gallic acid and 20 ounces filtered soft water into a clean bottle, expose before a fire, shaking occasionally until the gallic acid is dissolved. Add 6 or 8 pieces of camphor to keep it better and to insure clear lights in the negatives. Before use, carefully filter the requisite quantity, pour it into a dish and add 1 drop of a 30-grain aceto-nitrate solution to each ounce. In order to develop the exposed papers, float them on this bath, face downward, carefully avoiding air-bubbles. Take one paper at a time, float it, and when the sheet lies quite flat on the surface and the image begins to appear, raise it with the horn forceps, turn it over, and immerse it face upward. If there is any tendency in the papers to float on the surface, it is because they are not sufficiently saturated, and they must be kept under with the glass triangle until they remain beneath. They may then be left until the whole of the details are brought out, when, if the skies are not black enough, a few more drops of silver solution should be added to bring up the intensity. This addition of silver must be continuously made, for if too much be used the lights will acquire a dingy appearance. When the skies look intensely black, and the image is slightly over-developed, the negative must be well washed in two changes of water, and may then be fixed as usual. The intensity is much reduced in the hypo bath. Under-exposed pictures can be treated with a 2-grain pyrogallic solution, with 2 drops of aceto-nitrate solution to the ounce, and when the details are well out can be returned to the gallic acid solution. Sometimes the paper acquires a dirty-yellow color in developing, but this is of no consequence; indeed, some of the best negatives are of this complexion.

The Fixing. Dissolve 1 ounce hyposulphite of soda in 8 ounces of water, and immerse the negative in it. After twelve negatives have been cleared in this bath a fresh one must be made. When the iodide of silver has been dissolved out, wash the negative in running water for three or four hours; finally press between blotting-paper and dry in a warm place or before a fire.

The Final Waxing. This is easily performed. Each negative is laid in a dish of hot, melted wax, and immediately becomes saturated. It is then raised, allowed to drip, placed between two sheets of blotting paper, and ironed with a moderately hot iron.

Camphor. Transparent, crystalline, grainy mass. Very soluble in alcohol, ether, chloroform, acetic acid, benzole, and in oils; with difficulty in cold water. Is used with gallic acid, blood-serum, albumen, etc., to prevent fogging in the sensitive film; also in the salting solutions for paper, to prevent greater contrast.

Canada Balsam. Light-yellow, sticky substance, of the consistence of honey; insoluble in water, soluble in alcohol; used in cementing lenses together in objectives, as also to fix microscopic objects on their glasses and to seal colored lantern slides. It makes paper transparent.

Cane-Sugar. Sugar obtained from sugar-cane. Used in the silver bath for positive paper pictures. Preserves the whiteness of the paper.

Canton Flannel. A cotton cloth with very long nap, used by daguerrotypists for giving the first cleaning to the silvered plate.

Canvas Printing. (See *Fabrics.*)

Caoutchouc, Gum-Elastic, India-Rubber. A cream-like liquid, which dries to a soft elastic mass; soluble in benzine. Used in solution as a substratum for dry plates.

Cap. The round, velvet-lined cover of the lens, closing it before and after exposure.

Capsule. A shallow dish or saucer.

Caramel. Burnt sugar, which does not crystallize with gelatine or gum, for backing plates to counteract halation.

Carbolic Acid. C_6H_6O. Colorless, shining needles, soluble in water. Serves to keep gelatine and albumen solution, as also boiled starch, from moulding, as also to keep iron developer clear.

Carbon. The term carbon is employed to denote the pure inflammable part of charcoal, a substance obtained by various means and from divers sources. Common charcoal is obtained by burning wood in covered pits or piles. It is also obtained by exposing pieces of wood to the action of heat in close iron vessels. A large quantity of gaseous and acid products are distilled over in combination with a portion of the carbon; the rest of the carbon remains in the vessel in combination with any salts which may have been contained in the wood. Turpen-

tine, alcohol, resinous and oily matters yield carbon in a state of minute division and great purity. Charcoal is black, brittle, insoluble in water; destroys the taste and odor of many substances. It is infusible by heat, but exposed to the action of a powerful galvanic battery, it is partly volatilized; the remainder becomes so hard as to be capable of scratching glass, and its lustre is increased. It has the property of absorbing a large quantity of gaseous substances. It burns in atmospheric air, and with great brilliancy in oxygen gas; and from its power of deoxidizing many substances it is used to abstract oxygen from many metallic compounds; it also decomposes nitric acid. It is used in photography for decoloring silver solutions.

Carbonate. A compound of carbonic acid with a base. Carbonates are distinguished by the property of effervescing in the addition of acid.

Carbonate of Ammonia. This salt is composed of 17 equivalents, or 1 part of ammonia and 22 equivalents, or 1 part of carbonic acid, and may be made by mixing 2 measures of ammoniacal gas with 1 of carbonic acid over mercury; the two gases immediately combine. Used for fuming albumen paper and in development.

Carbonate of Lime. A very abundant natural production, found widely diffused over every part of the globe, occurring under a variety of forms, such as limestone, marble, chalk, Iceland spar, and also in crystallized state. It is sparingly soluble in pure water, but is held in solution by carbonic acid, and may be readily obtained from its solution by expelling the carbonic acid by boiling. Used as powdered chalk in neutralizing baths.

Carbonate of Potash. This salt is readily prepared by mixing equal weights of the nitrate of potassa and bitartrate of potassa, and throwing the mixture into a red-hot crucible. The nitric and tartaric acids are decomposed, part of the carbonic acid formed unites with the potassa, making a very pure salt, which has the character of being fused at red heat, and is deliquescent. It renders the solution of red cabbage green, and is less caustic than pure potash. The equivalents of crystals of carbonate of potash are: potassa, 48; carbonic acid, 22; water, 18. It can be obtained by stirring commercial pearl-ash in water; the subcarbonate will be dissolved, leaving the silver and sulphate of potassa. Carbonate of potassa is used in photography for reducing the ashes of silvered paper, the refuse of washings, etc., to metallic silver, and for purifying ether and alcohol. This salt has a great attraction for water, consequently, when alcohol is agitated with it, a portion of the water is removed, the salt dissolving in it and forming a dense liquid, which refuses to mix with the alcohol and sinks to the bottom. At the expiration of two or three days, if the bottle has been shaken frequently, the action is complete, and the lower stratum of fluid may be drawn off and rejected. The proportions should be about 2 ounces of the salt to 1 pint of alcohol. To purify ether, agitate it in the same way with the carbonate, and redistil at a moderate temperature. It is much used in alkaline developers and for removing water from ether, alcohol, etc.

Carbonate of Silver. Ag_2CO_3. A light-yellow, light-sensitive powder, difficult of solution in water, very soluble in ammonia; precipitated from nitrate of silver by alkaline carbonates. Used in negative silver baths to neutralize free acid, also in the preparation of gelatino-bromide of silver emulsion.

Carbonate of Soda. Na_2CO_3. Colorless crystals, easily decomposed by air, very soluble in water. Used, like carbonate of potash, in alkaline developers; also to neutralize various baths, to remove sizing from paper, and in the preparation of nitrate of soda. Calcined soda (carbonate of soda, freed from its water by red heat) is used in the reduction of silver waste.

Carbonized Plate Process. This process is the discovery of Dr. Schafhaentl.

Metallic plates are covered with a layer of hydruret of carbon, prepared by dissolving pitch in alcohol, and collecting the residuum on a filter. This, when well washed, is spread as equally as possible over a heated, even plate of copper. The plate is then carbonized in a closed box of cast iron, and, after cooling, passed between two polished steel rollers, resembling a common copper-plate printing press. The plate, after this process, is dipped into a strong solution of nitrate of silver, and instantly exposed to the action of the camera. The silver is, by the action of the rays of the sun, reduced to a perfectly metallic state, and the lights are expressed by the different density of the milk-white deadened silver, the shadows by the black

carbonized plate. In a few seconds the picture is finished, and the plate is so sensitive that the reduction of the silver begins even by the light of a candle. For fixing the image, nothing more is required than to dip the plate in alcohol mixed with a small quantity of the hyposulphite of soda, or of pure ammonia.

Carbon Printing Process. This photographic process was invented by M. Poitevin, but first practically introduced by Mr. Pouncy, of England, in 1858. Since that time it has undergone various modifications and improvements.

The processes of Messrs. Fargier, Swan, Johnson, Marion, and others, are to be found in the manuals devoted to the process, and in other sections of this work. With all the industrious experiment, in all these years, carbon printing has not attained popularity among practical workers, beautiful though the process is. The manuals give full details.

Card, Carte, Carte-de-visite. Name for photographs of a certain size (6 x 10 cm., size of plate 9 x 12 cm., or quarter-plate).

Carriers are thin frames, fitted into the plate-holder, for exposure of smaller plates. "Kit-frames."

Cartes Russes, bust-pictures, swimming out into black ground (black vignette), usually made by interposition of a large vignetter between sitter and camera, or a small one between lens and sensitive plate in the camera. They can also be made from common negatives, by first printing a white vignette, and afterward, by double printing, bringing the white ground up to the tint of the vignette, while protecting the latter with an oval corresponding to the vignetting mask, and pasted on a glass, keeping the latter in motion to avoid sharp lines.

Cartridges. Designation of the manner of packing powdery substances, for instance, "developing cartridges," "toning and fixing cartridges," "flash-light cartridges," etc. They contain just enough for one application, and have the advantage of convenience, especially when travelling.

Caseine. The curd or coagulable portion of milk. Cheese made from skimmed milk and well pressed, is nearly pure caseine. When caseine is thrown down from skimmed milk, by adding an acid, it combines with a little of it and forms a kind of salt. The acid may be removed by means of carbonate of lead, when pure caseine is left behind.

The substance termed "rennet," which is the dried stomach of the calf, possesses the property of coagulating caseine. Sherry wine is also commonly employed to curdle milk. In all these cases a portion of the caseine usually remains in a soluble form in the *whey;* but when milk is coagulated by the addition of acids, the quantity so left is quite small, and hence the use of rennet is to be preferred, since the presence of caseine facilitates the reduction of the sensitive silver salts. Caseine combines with oxide of silver in the same manner as albumen, forming a white coagulum, which becomes *brick-red* on exposure to light. This substance makes a very good film for glass or paper upon which to spread the sensitive coating.

Caseine has been applied as a substitute for collodion. Dissolve the caseine in ammonia, and add the iodide and bromide of ammonium, as in collodion, and a perfectly homogeneous fluid is obtained, which flows over the glass perfectly. In precipitating the caseine from skimmed milk some cream is carried down, but is got rid of as above stated. Caseine, at certain temperatures, combines with oxygen and becomes insoluble in water; therefore, in preparing the plates, they should not be exposed to a heat of more than 212°, but with that they would form a glossy surface, which could not be distinguished from albumen. If plunged in an ordinary thirty-grain nitrate bath, it will coat almost as quickly as collodion, and it may be used either in its wet or dry state, developing with ordinary pyrogallic acid, in which citric acid should be used instead of acetic acid, as the latter is apt to dissolve the film.

Hyposulphite of soda should be used for fixing, as cyanide of potassium dissolves the caseine. When the picture is cleared, it is only necessary to dry and heat it again, when the film becomes so hard that it can be scarcely scratched with the finger-nail.

Cassette. Dark slide, plate-holder, double back, carrier; the receptacle for the sensitive plate, and substituted for the ground-glass during exposure in the camera; its door, by the removal of which the plate is exposed, is called slide, dark slide, or shutter.

Cassettenschnaepper. An attachment preventing accidental double exposures of the plate, consisting of a spring, which, after shutting the slide, catches behind a hook

fastened on the plate-holder, preventing a second removal of the slide.

Catalysotype. A curious and intricate process for obtaining direct positive pictures in the camera upon paper, devised by Dr. Woods, and described at length in Hunt's *Manual of Photography*, 1853.

Catechol. Syn., Pyrocatechin, brenzcatechin. This is a developing agent obtained by heating its methyl salt, guaiacol, with concentrated aqueous hydriodic acid. In practice it gives clear negatives, with less density for a given exposure than pyro or hydroquinone. Its price militates against its adoption for general use as yet. The formula for gelatine dry plates is as follows:

A.	Caustic Potash	10 parts.
	Water	1000 "
B.	Catechol	2 parts.
	Sodium Sulphite	10 "
	Water	100 "

For use mix 5 parts of A and B each with 100 parts of water, adding bromide of potassium as a restrainer, if required.

Catechol is an excellent developer for transparencies, the subjoined formula being used for this purpose:

A.	Potassium Carbonate	1 part.
	Water	10 parts.
B.	Catechol	1 part.
	Water (distilled)	50 parts.

For soft, detailful transparencies use A, 20 parts; B, 3 parts; water, 60 parts. Catechol has a strong tanning action upon the gelatine film and is, therefore advised for use in hot weather and tropical countries.

Catoptrics. The law of reflection of light-rays.

Caustic. Any substance which, applied to living animals, acts like fire in corroding the parts and dissolving the texture.

Caustic Potash. KHO. A white crystalline substance, usually moulded in sticks; very hygroscopic. Being an alkali, it is useful in alkaline development. In the hydroquinone development it serves as an accelerator.

Caustic Soda. Sodium hydrate; NaHO. A white, transparent, brittle and deliquescent substance, very alkaline, and very soluble in water or alcohol. In character it is very like caustic potash.

Celerotype. A gelatino-chloride print-out paper used in England.

Celestial Photography. The art of photographing the heavenly bodies. The manipulations in this branch of photography are the same as in *Lunar Photography*, which see.

Celloidin. A very pure variety of pyroxylin, or collodion cotton, known as Schering's celloidin, suitable for all kinds of collodion-making or collodion emulsion work, especially for the latter purpose, on account of its flexibility, transparency, and ability to keep the silver emulsified. It is readily obtainable shredded, in one ounce packages, similarly with gun-cotton.

Celloïdin Paper. A collodion-emulsion paper, prepared with celloidin-cotton, for printing positives under negatives.

Celluloid. A combination of nitro-cellulose and camphor. The German celluloid contains besides, a small percentage of coloring matter. Resembles hard rubber or ebonite, but is much more elastic and may be colored so as to be transparent or opaque. When cold is easily worked with any tool, not splitting. Soluble in ether and alcohol, insoluble in water. Serves for making utensils (dishes and baths), also as support for films, so-called celluloid films or pellicles.

Celluloid Films. Are prepared by means of a solution of pyroxylin in a mixture of methyl and amyl alcohols, and amyl, propyl, and butyl acetates, with the addition of gum-camphor if a viscous solution is desirable. To avoid the buckling and bulging of celluloid films used as a support for gelatino-bromide emulsions, the film is protected on both faces by a "sealing coating," that on the back of the film consisting of gelatine made insoluble with chrome-alum, that on the face being the gelatine emulsion itself. These methods are patented.

Used celluloid films are of no value; they may be freed from the coating of emulsion by treating them with soda and hot water; the clean films may then be dissolved in 50 times their bulk of amyl acetate, and the solution utilized as an excellent negative varnish.

Cellulose. (See *Lignin.*)

Cellulose Process. A process of little or no consequence to the art. The cellulose or lignin is dissolved in alcohol, and sensitized and used in the same way as collodion.

Cementing. I. When vapors of watery liquors, and such others as are not corrosive, are to be confined, it is sufficient to surround the joining of the receiver to the retort with

slips of wet bladder, or of linen, or paper, covered with flour paste or mucilage of gum arabic. II. Soft cement is made of yellow wax melted with half its weight of turpentine and a little Venetian red to give it color. It can be easily moulded by the fingers, and sticks well to dry substances. III. For containing the vapors of acids, or highly corrosive substances, *fat-lute* is made use of. This is formed by beating perfectly dry and finely sifted tobacco-pipe clay, with painter's drying oil, in a mortar, to such a consistence that it may be moulded by the hand. To use it, it is rolled into cylinders of a convenient size, which are applied by flattening them to the joinings of the vessels, which must be quite dry, as the least moisture prevents the lute from adhering. The lute, when applied, is to be covered with slips of linen spread with the lime lute, which slips are to be fastened with pack-thread. IV. When penetrating and dissolving vapors are to be confined, the lute to be employed is of quicklime slacked in the air and beaten into a liquid paste with white of eggs. This must be applied on strips of linen; it is very convenient, as it easily dries and becomes firm. This lute is very useful for joining broken chinaware. V. For cementing stoneware to metals and wood, litharge and red lead mixed and worked up with spirits of turpentine makes a good cement. It takes several days to give off the turpentine, and becomes dry and hard. VI. For cementing brass necks on glass jars, etc., take of resin, 4 parts; wax, 1 part; finely powdered brick, 1 part; melt, and mix well together. It is to be put on warm, but care is to be taken not to apply it so hot as to split the glass. It holds very hard. VII. Mix linseed meal with water, and knead it into a stiff paste. It soon hardens and withstands the fumes of acids and ammonia. It is better if made with lime-water or thin glue. It is charred by a strong heat. VIII. Thick gum-water with pipe-clay and iron filings; mix well. It becomes very hard and firm, and is fit to be used where it is required to hold good for a considerable time. IX. Plaster-of-Paris stirred up with milk, starch-water, or thin glue; for securing tubes in flasks. X. Dissolve melted India-rubber in boiling linseed oil, and thicken with pipe-clay until it forms a stiff mass. XI. For fastening labels to bottles, soften and subsequently boil glue in strong vinegar. During the boiling thicken it with flour. When used, spread with a spatula warmed over a lamp. (*Gray.*)

Central Spot. Flare spot; a fault in the old globe-objective, and some others, consisting in producing in the centre of a picture a bright, round spot when the camera, during exposure, is pointed toward a powerfully illuminated object (for instance, the sky). Due probably to reflections emanating from the edges of the lens.

Central Stop. Diaphragm placed midway between two lenses; central diaphragm.

Centrifugal Separator. An apparatus used in the preparation of gelatino-bromide of silver emulsion, for separating the bromide of silver from the gelatine emulsion, removing it from the decomposed gelatine. The receptacle, containing the emulsion, rotates with a rapidity of 4000–6000 revolutions a minute, throwing the entire bromide of silver against the sides of the dish by centrifugal force.

Ceramic Photography. Vitrified, burnt-in, or enamel photographs may be produced in two ways: the *substitution* or *powder* process. Both processes, however, are beyond the skill of the average photographer, and require great patience and experience; the result, moreover, is somewhat uncertain even in expert hands. In the *substitution process* a wet-plate transparency of the subject desired is first made, developed with pyro, and fixed with potassium cyanide. The film is then floated from its support, caught on a piece of plain glass, and toned with iridium and gold chloride. It is then transferred to the porcelain tablet or china plate, etc., and the image is burnt-in by being placed in a china kiln or muffle. This causes the disappearance of the picture, which is restored by the application of an enamel glaze and further burning-in. This last procedure is repeated until the full beauty of the picture is brought out.

In the *powder process* the tablet or final support is coated directly with a bichromated film in the dark, dried by heat, and exposed under a transparency. The exposed surface is then allowed to become slightly moist, and an enamel powder is dusted on so that the image is developed. All traces of the bichromate are then removed by immersing the tablet in water acidulated with sulphuric acid, and again washing in water. When dry, it is ready for burning-in and glazing,

which is done as described for the substitution process. For further details the reader may consult Duchochois' work on *Industrial (Ceramic) Photography.*

Cerate. A solution of wax and gum elemi in benzene and oil of lavender. Serves to give gloss to albumen prints.

Cereoline. That portion of white wax soluble in alcohol.

Cereolinated Collodion. By addition of cereoline to collodion cracking and reticulation is prevented. Before dissolving the guncotton saturate the alcohol and ether with cereoline.

Cerium Printing. Messrs. Lumière Bros. have recently made known the results of their investigations with cerium salts for use in photographic printing. They state that the cerous salts are stable, but the ceric salts are easily reduced, and they obtained good results with ceric sulphate and nitrate, using water solutions of these salts in their experiments. The prints were developed with a carbon compound of the aromatic series. No definite formula or method of procedure has yet been given.

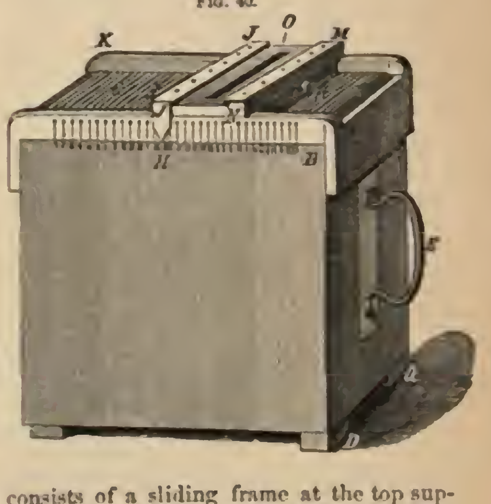
Chalk Background. It is sometimes desirable to conceal the photographic background in a proof, without bestowing any great amount of time or trouble upon the process. When this is the case you can adopt no better method than that of rubbing in a chalk background. This may be done in the following very simple way: Procure some Swiss crayons of the various tints and colors necessary for background effects; reduce them to powder carefully, and, with a leather stump, rub the colors into the background, adding here a little warm color, there a little cold, keeping this lighter or darker, as the nature of your subject and the due consideration of breadth and relief may demand. When near the outlines of the head or figure use a finer-pointed stump and more care. A sky may be wrought in with excellent effect and no more labor, by first rubbing in the forms of light clouds melting into a blue or bluish gray, as the case may demand, and then using a darker and somewhat warmer gray for the heavier masses. A few touches with pale orange and flesh colors near the horizon will produce a pleasing effect and serve to repeat, artistically, the colors of the face. When a surface of crayon thicker than that so obtained is thought desirable, a *previously* applied "wash" of body color will be of great assistance. Use on plain, not on albumen paper.

Chalky Deposit. White, pulverulent deposit on the surface of the negative after drying; occurs mostly in oxalate of iron development and is attributable to washing the negative in water containing lime. Generally removed by bathing in a 1 per cent. solution of hydrochloric acid.

Chalky Print. A photograph with too strong contrast between light and shade, without half-lights.

Changing-Box for Dry Plates. In the old dry processes an apparatus of this construction was used by out-door workers for changing their plates in the field. The box

FIG. 40.



consists of a sliding frame at the top supplied with a brass track to fit the plate-holder. This also moved across the top of the box, as shown by the figures at *H B*, but in moving, opened an aperture in the top of the box when the plate dropped from the holder. The holder was refilled by overturning the box and allowing the plate to drop in its place. Modern methods have placed this almost out of use.

Chemical Affinity. Of all the phenomena which the study of chemistry presents, chemical affinity is the great cause to which they are referred. Light, heat, electricity, cohesion, and other causes modify its action, but the details to which we give our attention in the examination of particular substances

are, almost exclusively, but the effect of this principle. It is, therefore, necessary to become familiar with the circumstances which modify its action, and especially the laws which produce these modifications. Chemical affinity is considered *an attraction which acts only at insensible distances between particles of different kinds.*

Chemical affinity, or chemical attraction, exerts its influence between particles of an opposite nature, combines them together, and forms a substance entirely different from either of its components. These may be exemplified by the union of powdered *silica* and *potash* in the formation of *glass;* in the union of *chromic acid* with *potash;* in the combination of iron with sulphur; and numerous other instances characteristic of the very singular difference which the resulting compounds bear to their original components. It is at all times necessary that immediate contact should take place between the particles of the opposite kinds of matter before combination can follow, and if pulverized, great assistance will be given to their union; and although not absolutely essential, yet solution of the bodies will greatly facilitate their combination.

Many important changes take place between bodies exposed to the action of this powerful agent. Among the most conspicuous of these may be enumerated, change of color, form, temperature, and bulk. Thus, for example, a change of color, very obvious and very beautiful, will take place when a solution of the prussiate of potash is added to a solution of sulphate of iron—a *blue* precipitate will fall down, at first but pale, darkening, however, very gradually, until a deep Prussian blue results.

A deep yellow, the chromate of lead, falls down when a solution of the acetate of lead is added to a solution of the chromate of potassa.

A beautiful grass-green colored precipitate is given when a solution of the arsenite of potassa is added to a solution of the sulphate of ammonia.

A splendid scarlet results from mixing together solutions of the bichloride of mercury and hydriodate of potassa.

A black is produced by adding the hydrosulphuret of ammonia to the acetate of lead.

A curdy white copious precipitate falls down when the acetate of lead is added to the sulphate of zinc.

In all the above examples the changes which take place to produce the new compounds are so many instances of what is known in chemical language by the name of double decomposition, double elective affinity, and double elective attraction, which is easily explained by stating that the two acids of the mixed substances change bases, or that the two bases change their acids, they each having a greater predilection for the other's acid than it had for its own, and *vice versa.* This action may be better understood by the following diagram. Thus, solutions of sulphate of zinc and acetate of lead are mixed:

	Composition.	Composition.	
Sulphate of zinc.	Sulphuric acid.	Acetic acid.	Acetate of lead.
	Oxide of zinc.	Oxide of lead.	

The result of this action being the sulphate of lead and the acetate of zinc.

When muriate of baryta is added to water containing sulphuric acid, the baryta leaves the muriatic and unites with the sulphuric acid, forming a new compound, the sulphate of baryta, which is precipitated, leaving in solution the muriatic acid.

When oxalic acid is added to a solution of a soluble salt of lime, an oxalate of lime is precipitated, and the other acid remains in a free state with the water. These are two instances of what is called single elective attraction, or, in other words, the bases had a greater affinity for the acids added than they had for the ones with which they were previously united. This affinity differs from double elective attraction in there being only three substances brought into action, whilst in the other case there are four.

By chemical affinity bodies pass from solids into fluids, fluids into solids, and gases into solids. For example, when crystallized nitrate of ammonia and sulphate of soda are rubbed together in a dry mortar, a liquid is the result of the action excited between the two salts.

When carbonate of potassa and muriate of lime in a state of strong solution are mixed together in a glass, and the mixture stirred briskly with a spatula or glass rod, a solid compound, the muriate of potassa and carbonate of lime, is produced.

When water is poured upon newly-burnt

quicklime it loses its fluidity and becomes a solid body.

When muriatic-acid gas is made to pass into a glass globe containing ammonia in a state of vapor, a white powder is formed; this results from the combination of the two gases.

If gold leaf, finely powdered arsenic, or antimony, be put into a bottle containing chlorine gas, immediate combination ensues, accompanied by a great increase of temperature and light.

If water and alcohol be mixed together, considerable heat is evolved.

When sulphuric acid and water are mixed considerable heat is produced, and a diminution in the bulk of the bodies, or at least in the bulk of the water added, is the consequence of their combination.

That one substance has a stronger affinity for some than for others cannot be doubted; but combination and decomposition do not always depend upon the relative force of affinity alone. The circumstances which modify the operation of this power are *cohesion*, *elasticity*, *quantity of matter*, *gravity*, and the *imponderable agents*.

In order that substances should combine with each other, it is necessary that their particles should be in contact; but *cohesion* holds together the particles of each substance, so that they cannot freely intermingle. Cohesion must therefore be destroyed to facilitate chemical action. This is effected in three ways—by reducing the substance to a powder, by solution, and by heat, examples of which we have given.

Solution is effected when a solid is put into a liquid, and entirely disappears, leaving the liquid clear. The body which thus disappears is termed soluble; the liquid is called the solvent, and the compound liquid a solution. Water, alcohol, ether, oils, alkalies, and acids are the usual solvents. When a solvent has dissolved as much of any substance as it can, it is said to be saturated, and the solution is called a saturated solution. Solution should not be confounded with diffusion, which is a mere mechanical mixture. The distinction can be seen by mixing magnesia in water. The particles of magnesia are suspended at first in the water, rendering it turbid, and they would soon subside to the bottom; but if nitric acid be added the magnesia will be dissolved, and the water will become clear.

As most substances are more soluble in hot than in cold water, it results that, as a hot saturated solution cools, the water will not be able to hold in solution all the substance that had been dissolved, and it appears again in a solid state. The power of cohesion has the ascendancy over the affinity of the liquid for the solid, and forms the latter into crystals. Hence the phenomena of crystallization are owing to the ascendancy of cohesion over affinity.

By evaporation, also, the solid may be recovered from solution. In either case the crystallization is confused, especially when the process is rapid.

Insolubility has been found to exert a remarkable influence on affinity, in the case of an alkali with two acids, or an acid with two alkalies, one of which will form with the alkali a soluble, and the other an insoluble compound. The one which is insoluble is always formed in preference to the soluble compound.

Fusion is the reduction of a solid to a liquid state by heat, and facilitates chemical action by enabling the particles to intermingle and come within the sphere of each other's affinity. In liquids a slight degree of cohesion remains, and hence heat is applied to them with advantage. A hot liquid will act more powerfully upon a solid than the same liquid when cold.

Cohesion, as we have seen, opposes chemical action by keeping the particles out of the sphere of each other's influence. Electricity, or the gaseous state, is still more unfavorable, because the particles are farther removed from each other, and require greater attractive force. Hence most gases, though possessing strong attraction for each other, will not combine unless they are in the nascent state, that is, when in the act of assuming the gaseous form. In this way elasticity not only prevents chemical union, but it favors decomposition. When two highly elastic cases combine, forming a liquid or solid, the compound will become decomposed by a very slight cause. Generally, all compounds which contain a volatile principle are easily decomposed by a high temperature. Hence caloric sometimes favors chemical action by destroying cohesion, while at others it prevents it and favors decomposition by promoting elasticity.

There are some gases, however, which readily combine at a high temperature, as in

the case of gaseous explosive mixtures; thus oxygen and hydrogen gases require the heat of a flame to effect their union.

Quantity of matter is another cause which effects chemical affinity. Generally, when one substance combines with another in several proportions, the affinity is stronger in the case of the less than of the greater portions. In consequence of this influence of quantity of matter over chemical changes, chemists generally employ more of one substance than is necessary to effect the decomposition of another. On this principle, also, when a salt is dissolved in water, the first portions are dissolved more rapidly than the last, and the force of affinity diminishes up to the point of saturation, when it is overcome by the cohesion of the solid.

The influence of gravity on chemical action is seen when substances of different specific gravities combine. As when two liquids are put together, the heavier liquid will sink to the bottom; or when salt is dissolved in water, the salt will remain at the bottom, and prevent the particles of water from coming into contact with those of the salt.

The influence of caloric over chemical phenomena, as before stated, favors chemical action in the case of solids, by destroying cohesion, and opposes chemical action in the case of gases, by increasing their elasticity. Common electricity is often employed for the combination of gases, and galvanism for decomposition, but the same effects may be produced by either.

Chemical Coloration of Proofs. A process, or series of processes, recommended by M. Evrard, for changing, strengthening, or weakening photographs on paper and glass, and for modifying them almost infinitely in coloration and appearance—strengthening the shade, giving due brilliancy to the lights; finally, affecting gradations and fineness of tone, which the hyposulphite in its simple state could not produce. Now obsolete.

Chemical Compounds. When several substances unite by means of chemical affinity they are styled chemical compounds. (See *Chemical Affinity.*)

Chemical Elements. By chemical elements is meant a substance which has never been derived from, or separated into, any other kind of matter, such as gold, silver, oxygen, hydrogen, and sulphur.

Chemical Focus. The exact focal distance from the lenses of the camera at which the sun's rays act to form an image upon the daguerrotype, or glass plate, and which should always agree with the visual focus upon the same plane. In purchasing a lens the operator should always ascertain that this is the case, and when the difficulty does occur have it remedied. The lenses are now so perfectly constructed that the fault usually lies in the spectrum, or plate shields. A few shavings taken from one or the other speedily corrects it.

The same causes which produce chromatic aberration in a lens also tend to separate the chemical focus of the lens from the visual focus. The *blue*-colored ray is more strongly bent in than the yellow, and still more so than the red; consequently the focus for each of these colors is necessarily at a different point. Now, as the chemical action corresponds more to the blue, the most marked actinic effect would be found a little nearer to the lens, the chemical rays being even more refrangible than the visual rays. The luminous portion of the spectrum, however, is not at the blue, but at the yellow, consequently the visual focus would be equidistant between the blue and red rays. It is usually said that the compound achromatic lens coincides in chemical and visual focus; but it is well to ascertain the fact for each instrument. To do this, proceed as follows: First, ascertain that the prepared sensitive plate falls precisely in the plane occupied by the ground-glass. Suspend a newspaper or a small engraving at the distance of about three feet from the camera, and focus the letters occupying the centre of the field; then insert the slide, with a ground-glass substituted for the ordinary plate (the rough surface of the glass looking inward), and observe if the letters are still distinct. If the result of the trial seems to show that the lens is good, proceed to test the correctness of the lens. Take a positive photograph with the full aperture of the lens, the central letters of the newspaper being carefully focussed as before. Then examine at which part of the plate the greatest amount of distinctness of outline is to be found. It will sometimes happen that whereas the exact centre was focussed visually, the letters on a spot midway between the centre and edge are the sharpest in the photograph. In that case the chemical focus is longer than the other, and by a distance equivalent to the space which the ground-glass has to be

moved in order to define these particular letters sharply to the eye. When the chemical focus is the shorter of the two the letters in the photograph are distinct all over the plate; therefore the experiment must be repeated, the lens being shifted an eighth of an inch or less. Indeed, it will be necessary to take many photographs at minute variations of focal distance before the capabilities of the lens will be fully shown.

Chemical Nomenclature. The nomenclature of the chemical *elements.*

Chemical Rays. The rays of light supposed to produce chemical decomposition, but neither heat, expansion, vision, nor color.

Chemical Sensitizers. Bodies which increase the photographic sensitiveness; in other words, accelerators.

Chemical Spectrum. The solar spectrum allowed to fall upon a prepared chemical surface.

Chemigraphy. Zinc etching. A process of making zinc etchings after drawings without photography.

Chemistry. Is the science which discovers the constituent principles of bodies, the results of their various combinations, and the laws by which these combinations are effected.

Chemitype. A peculiar style of colored photograph, invented by Mr. C. A. Seely, of New York. Two positives on glass are printed in the following way: Take a negative and fasten on the corners (of the collodion side) small pieces of thin cardboard, then lay it upon a glass sensitized with collodion, and expose to light. A printing frame is not necessary, as the time of exposure is very short, one or two seconds being sufficient in a weak light. It is advisable to print with lamp-light, or otherwise reduce the light so that fifteen or twenty seconds may be used. The print is developed in the usual way, and may be colored or toned by variations in the developing, or afterward by chloride of gold or bichloride of mercury. This coloring will be found necessary, as the developer does not leave the shadows dark enough. The collodion used in printing must leave a perfectly transparent film when dry, and should be made somewhat thinner than for negatives. I would suggest chloride of ammonium as the sensitizer, for the reason that the collodion may be used dry, and so permit a closer contact of the two plates, and that it is not so sensitive as ordinary collodion. One of these positives must be varnished with a thin solution of gum-arabic and colored. The other must be varnished with white shellac or amber varnish. Place the colored picture behind the plain one, so that the outlines of both accurately coincide or fit, and seal them together and back them up with fine white cardboard. The effect is very pleasing and natural. Anyone can do the coloring, as it requires very little skill, mere dashes of the different tints in the right place being all that is necessary.

Chiaroscuro. The art of distributing lights and shadows in painting. The term in the language of art means not only the mutable effects produced by light and shade, but also the permanent differences in brightness and darkness.

China Clay. (*Kaolin.*) This is prepared by careful levigation from mouldering granite and other disintegrated felspathic rock. It consists of the silicate of alumina—that is, of silicic acid, or flint, which is an oxide of silicon, united with the base alumina (oxide of aluminum). It is perfectly soluble in water and acids, and produces no decomposition in solutions of nitrate of silver. Commercial kaolin may contain chalk, in which state it produces alkalinity in solutions of nitrate of silver. The impurity, detected by its effervescence with acids, is removed by washing it in dilute vinegar, subsequently in water. It is employed by photographers to decolorize solutions of nitrate of silver which have become brown from the action of albumen or other organic matters, which it does by absorbing the brown matters.

Chinolin-Blue. Syn., Quinolin. (See *Cyanine.*)

Chinolin-Red. $C_{26}H_{19}N_2Cl$. Dark-red powder, or red-brown, brilliant prisms, very soluble in water, very light-sensitive. Serves as a sensitizer in gelatino-bromide of silver plates, imparting much greater sensitiveness to red rays. A mixture of chinolin-red with chinolin-blue (cyanine) gives azaline (Vogel).

Chlorate of Potash. Chlorate of potash, or potassa, has long been known as the oxymuriate, or hyperoxymuriate, of potassa. It crystallizes in four- or six-sided scales, is soluble in six times its weight of water at 60° and in two and a half its weight of boiling water. It fuses at 400° or 500° F., and at a red heat is decomposed and parts with

its oxygen. Specific gravity, 2. It is formed by passing a current of chlorine gas through a solution of potassa until the alkali is neutralized, boiling the solution a few minutes, and then evaporating until a pellicle is formed upon its surface. On cooling, the chlorate crystallizes and leaves the muriate of potassa in solution. On re-dissolving in distilled water, and again evaporating, the chlorate of potassa will be obtained very pure, in scales of a pearly lustre; deflagrating when thrown upon burning coals, and yielding peroxide of chlorine with sulphuric acid. This salt is remarkable for its colorific property, and may be used with advantage in changing the color and tone of photographs. Mr. Cooper recommends a solution of this salt, and a silver wash of 60 grains to the ounce of water as capable of forming a good paper, but it cannot be used where any great degree of sensitiveness is required. The color of the photographs assumes delicate-blue or lilac tints when this salt is used; or a golden-yellow, according to the other solutions employed. It is used in the manufacture of oxygen.

Chloride of Ammonium. This salt, also known as muriate or hydrochlorate of ammonia, occurs in commerce in the form of colorless and translucent masses, which are produced by sublimation, the dry salt being volatile when strongly heated. It dissolves in an equal weight of boiling, or in three parts of cold, water. It contains more chlorine in proportion to the weight used than chloride of sodium, the atomic weight of the two being as 54 to 60. It is used by photographers in collodion, in the soda developer, and for salting the paper. For plain paper it should be used in the proportion of 1 grain of the salt to 1 ounce of water. For albumen paper, 5 grains or more to the ounce of albumen. (See *Albumen Paper* and *Salted Paper*.)

Chloride of Barium. $BaCl_2$. Colorless, rhombic plates, not affected by air; serves occasionally for salting of paper, and as reagent on sulphuric acid, carbonate and iodide salts, with which it forms white precipitates.

Chloride of Bismuth. Mix together two parts of corrosive sublimate and one part of bismuth, both in powder, and expose the mixture to heat until all the mercury is expelled; a granular substance of a grayish-white color remains.

Chloride of Bromine. Made by passing dry chlorine through bromine and collecting the disengaged vapor in a receiver surrounded by ice. It is a very good accelerator, but there are others much better. It can only be used in a state of vapor, or combined with anhydrous alcohol or ether.

Chloride of Calcium. $CaCl_2$. Rhombic, very deliquescent crystals, containing water, which lose the latter at 200°, forming a flocculent, highly hygroscopic mass. Formed by heating lime strongly in chlorine gas, when oxygen is given off. It is soluble in alcohol, and imparts a red color to flame; used in drying or keeping dry platinum paper or gelatine films and in toning.

Chloride of Carbon. Expose the oily compound formed by mixing equal volumes of moist chlorine and olefiant gas, to the direct solar rays in a vessel full of chlorine gas. Hydrochloric acid is given off and perchloride of carbon formed. It is solid, smells somewhat like camphor, is twice as heavy as water; fusible, volatile; soluble in alcohol, ether, and oils, and slightly so in water. It is also combustible.

Chloride of Copper. Dissolve protoxide of copper in muriatic acid, evaporate and crystallize. This salt forms green needles, is deliquescent, soluble in alcohol, and when heated (under 400°) loses its water and becomes anhydrous chloride of copper, and assumes the form of a yellow powder. The *subchloride* of copper is made by distilling a mixture of 1 part of copper filings with 2 parts of corrosive sublimate. The first of these preparations is sometimes called the deutochloride, and the second the protochloride or muriate. A very dilute solution of chloride of copper is recommended as a bath in which to treat photographic prints after fixing in the hyposulphite bath. This destroys all traces of hyposulphite in the print. A solution of chloride of copper is also admirably suited to reduce over-exposed negatives.

Chloride of Gold. Obtained by dissolving gold in nitro-muriatic acid. With great excess of muriatic acid it crystallizes as yellow (acid) chloride of gold, which, if heated, solidifies into red-brown (neutral) chloride of gold, which melts in air, and, on that account, is usually kept in a glass pipe, closed by melting the ends. It is mostly used for toning prints, also for making gold salt (*sel d'or*) or the double salts of chloride of gold and sodium or potassium.

Chloride of Gold and Potassium. KCl, $AuCl_3 + 5H_2O$. A combination of chloride of gold with chloride of potassium; yellow crystals, which decompose in the air; serves to tone prints.

Chloride of Gold and Sodium. NaCl, $AuCl_3 + 2H_2O$. A mixture of chloride of gold and chloride of sodium; yellow prisms, not affected by air; serves for toning prints. The officinal salt contains but half the gold as the above, and consequently is cheaper.

Chloride of Iodine. When dry chlorine gas passes over dry iodine at common temperatures, heat is evolved, and a solid chloride is the result. It is of an orange-yellow color when the iodine is fully saturated, and reddish-orange when the iodine is in excess. It deliquesces in the air, is volatile, and very soluble in water, forming a colorless fluid, which exhibits acid properties. Chloride of iodine enters largely into the daguerrotype process. It was first applied by M. Claudet.

Chloride of Iridium. $IrCl_4$. A black, amorphous, transparent mass, soluble in water. It is used as an intensifier of collodion negatives, and in toning chloride of silver collodion, and albumen pictures.

Chloride of Iron. Perchloride of iron, ferric chloride. Fe_2Cl_6. Dark-brown crystalline rinds or crusts of metallic lustre, or garnet-red, shimmering tablets, melting in the air, very soluble in alcohol and ether. Used in gelatine emulsion (anti-fog); also, as reducer of intensity in negatives and as retarder in iron developer.

Chloride of Lead. Is easily formed by putting moistened salt into a solution of acetate of lead. A white precipitate is formed which must be washed in several waters. It is soluble in hot water; and also in cold by the addition of hyposulphite of soda. It is used by photographers in the formation of the toning bath. (See *Toning*.)

Chloride of Lithium. LiCl. White, deliquescent powder. Used in the preparation of chloride of silver collodion.

Chloride of Magnesium. Suggested by Dr. Liesegang as a substitute for hypo soda for fixing prints. The tone is not greatly changed by chloride of magnesium, and the washing may be shorter than is required for hypo soda. The subjoined formula is given:

Chloride of Magnesium	15 parts.
Alum	2 "
Water	100 "

This bath works with great rapidity.

Chloride of Mercury. Bichloride of mercury, corrosive sublimate, mercuric chloride. $HgCl_2$. A white crystalline mass. Used for strengthening negatives, for bleaching paper photographs (magic photos), for whitening positives on glass. Very poisonous. (See *Bichloride of Mercury*.)

Chloride of Palladium. This is a very expensive salt. Formed by chlorine and the metal palladium. It is usually sold in solution of twenty grains to the ounce. It is an excellent intensifier for negatives, and were it not for its high price would soon supersede every other. Two drops of the solution to the ounce of water poured over the negative after fixing and washing, in the same manner as for bichloride of mercury, will give an intense black. (See *Proto-Chloride of Palladium*.)

Chloride of Platinum. This compound is made by heating the bichloride, by which means one equivalent of chlorine is driven off. It gives matt-surface photographs called Platinotypes. (See *Platinotype*.)

Chloride of Potash. Potassium chloride. KCl. Colorless cubes, very soluble in water, insoluble in alcohol. Used in salting paper.

Chloride of Silver. Is often found native in silver mines, and is called *luna cornu*, or horn silver, and is always formed when muriatic acid or any soluble muriate is added to a solution of nitrate of silver. It is also prepared when silver is heated in chlorine gas. When first precipitated it is purely white; but when exposed to the action of light it takes a violet hue, approaching black in a very short time. It is insoluble in water, and nearly so in the strongest acids, but is soluble in ammonia and hyposulphurous acids. It fuses at 500° F., and passes into the state of a horny transparent mass, undecomposable by heat, but decomposed by passing over it a current of hydrogen gas, with the formation of muriatic acid. It is somewhat remarkable that great differences are observed in the color produced on chlorides of silver precipitated by different muriates. Nearly every variety in combination with the nitrate becomes *at last* of the same olive color; it must therefore be understood that the following notices apply to the color produced by an exposure of a few minutes only to good sunshine, and it must also be recollected that the chloride of silver in these cases is contaminated with the precipitant. Muriate of ammonia inclines the precipitated

chloride to darken to a fine chocolate-brown, whilst muriate of lime operates to the production of a brick-red color. Muriates of potash and soda afford a precipitate which darkens speedily to a pure dark brown, and muriatic acid and aqueous chlorine do not appear to increase the darkening power beyond the lilac to which the *pure* chloride of silver changes by exposure. As far as experiments have gone, it appears that this difference of color is owing to the admixture of the earth or alkali used with the silver salt, and not to the presence of organic matter, although it does, as in the case of the nitrate, produce similar varieties of color. The muriates of baryta and of strontium have some very peculiar colorific properties when in combination with the chloride and some other salts of silver. The chloride of silver was used as a photographic agent by Wedgwood, Davy, and Daguerre, their success being but very limited. This salt became, however, in the hands of Mr. Fox Talbot, of the utmost importance. (See *Calotype*.)

Chloride of Sodium. Common salt. NaCl. Colorless crystals, soluble in water. Used in salting paper in the silver-print process, for precipitating chloride of silver from the washing waters, as accelerator in alkali developers, and to clear discolored silver baths.

Chloride of Strontium. This salt is produced in the decomposition of the carbonate or sulphate of strontium by muriatic acid. As it is very deliquescent in air I do not recommend the use of it for the preparation of positive papers with chloride of silver. German and English operators, however, have recommended its employment. It might be useful in a case where we have no other chloride at our disposal. I cannot too urgently recommend the photographer to consider well the operations he has to make, so that he may be able to reap advantage from everything which he has at command, and thus to replace whatever may be required for making an operation regular in its progress.—*Le Gray*.

Chloride of Zinc. $ZnCl_2$. Water-free chloride of zinc is a whitish, deliquescent mass, very soluble in water and alcohol. Used in bromide-of-silver collodion.

Chlorides. Saline combinations of the elements with chlorine (haloid salts). In combination with oxygen and hydrogen, chlorine forms acids.

Chlorinated Lime. Hypochlorite of lime, dry chloride of lime. $CaCl_2O_2$. White, sticky powder, becoming decomposed by air and light, thus losing its active strength. Used in toning baths, imparting keeping qualities. Has strong bleaching properties; is also used in the preparation of Eau de Javelle.

Chlorine. A simple gas, combustible, possessing a very disagreeable odor, acid taste, and a greenish-yellow color. Combined with heat chlorine attacks all the metals, cauterizes and disorganizes animal membranes when damp, which is the cause of its fatal action on the lungs when respired. Chlorine is used in the daguerrean art combined with gold, iodine, and bromine; in the first case to whiten or bleach the picture, and in the latter as an accelerator. Liquid chlorine gives us a paper possessing in an eminent degree the merits of that prepared with muriatic acid, and has the advantage of retaining its sensibility much longer.

Chloro-Bromide of Iodine. A very stable preparation of these three substances—chlorine, bromine, and iodine—is formed by adding, drop by drop, red chloride of iodine to a saturated solution of bromine in water until the liquid, after reposing some time, emits no more fumes of bromine.

Chloro-Bromide of Lime. As its name indicates, this is a combination of chlorine, bromine, and lime.

Chloro-Chromic Acid. This is a beautiful salt made by the addition of a small portion of chlorine to chromic acid, evaporating and crystallizing. The crystals are of a brilliant carmine color and very deliquescent, and should be kept in a closely stoppered bottle. It is supposed that this compound will enter largely into any substance discovered for taking pictures in the natural colors.

Chloro-Cyanine. Formed by the action of hydrochloric acid on iodo-cyanine; is recommended as a better sensitizer for red, in orthochromatic work, than the commercial iodo-cyanine, working without fog.

Chloroform. This substance is best obtained by distilling alcohol or wood spirit with a solution of chloride of lime. It is an oily, colorless liquid of an agreeable, ethereal odor, and of a sweetish taste. No person should use chloroform which is not known to be properly prepared, as, when impure, it produces fatal effects when inhaled. It serves as a solvent of rubber, gutta-percha, and asphaltum.

Chlorophyll. The green coloring matter of plants; used as a sensitizer for red and yellow in orthochromatic processes by Ives and others. Crude chlorophyll is prepared by treating chopped green leaves with warm alcohol for 10 minutes, then filtering. It is best used fresh, but may be preserved *in the dark* in contact with powdered zinc. Dr. Schunck has recently prepared a new variety, more stable to light than ordinary chlorophyll, the preparation of which he gives as follows: "Alkaline chlorophyll is best prepared by extracting fresh grass leaves with boiling alcohol (80 per cent.); the solution is filtered hot, and on cooling deposits crude chlorophyll. This is boiled for some time with alcoholic soda, filtered, and the filtrate saturated with carbonic anhydride. The precipitate is extracted with cold alcohol, saturated sodium chloride solution is added to the solution, then the resulting precipitate is dissolved in boiling alcohol, and the solution is evaporated to dryness. The residue, after washing with a little cold water, is found to be a sodium compound; but on treatment with the requisite quantity of acetic acid, extracting with ether, and evaporating the ethereal solution, a green substance free from sodium is obtained." This Dr. Schunck calls alka-chlorophyll. It is amorphous, soluble in alcohol, ether, chloroform, benzene, carbon disulphide or aniline, giving bluish-green solutions showing a red fluorescence.

Chloro-Platinite of Potassium. Syn., Platinotype Company's "Red Salt." A salt prepared from platinum chloride, occurring in reddish, deliquescent crystals, freely soluble in water. Used in platinum printing and toning. Ferrous oxalate reduces this salt to metallic platinum, and its use in the platinotype process depends upon this fact.

Chromate. A saline compound formed by the union of chromic acid with a base. The chromates are characterized by their yellow or red color, the latter predominating when the acid is in excess. Recent experiments have led to the supposition that to the chromates we are to owe photographs in the natural colors.

Chromate of Copper. Prepared by precipitating a salt of copper with neutral chromate of potassa; or, dissolve hydrated peroxide or carbonate of copper in chromic acid. This chromate was first applied to photographic purposes by Mr. Robert Hunt, and gave rise to the possibility of obtaining in photography the natural colors. (See *Chromatype.*)

Chromate of Potash. This is prepared by exposing to a red heat the native chromate of iron and nitrate of potassa.

Chromate of Silver. A deep red or purple salt made by mixing a soluble salt of silver with neutral chromate of potash. Chromate of silver does not change much in color under the action of light, even after an exposure to good sunshine for many days, but it eventually assumes a very metallic brown shade.

Chromatic. Relating to color; having color—in contradistinction to achromatic.

Chromatic Aberration. The greater refraction of violet and blue rays, as compared with that of the red and yellow, causing the lens-picture to show colors at the edges. This fault is corrected by the union of two lenses of different kinds of glass (crown- and flint-glass) possessing differing color—diffusing characteristics. (See *Aberration.*)

Chromatic Background. This was the invention of Dr. Dorat, and gives a pleasing effect to the picture. (See *Background.*)

Chromatic Lens. A chromatic lens is one having color, or producing color by decomposing white light.

Chromatic Stereoscope. The chromatic stereoscope is a form of the instrument in which relief or apparent solidity is given to a single figure with different colors delineated upon a plane surface.

Chromatint. A name given (by Mr. L. L. Hill, as a new discovery) to the old French method of coloring in oil on the back of a varnished picture as applied to photographic prints.

Chromatype. A photographic process, discovered by Professor R. Hunt, by whom it is thus described: This process is a pleasing one in its results; it is exceedingly simple in its manipulatory details, and produces very charming positive pictures by the first application. One drachm of sulphate of copper is dissolved in an ounce of distilled water, to which is added half an ounce of saturated solution of bichromate of potash; this solution is applied to the surface of the paper, and, when dry, it is fit for use, and may be kept in the dark any length of time without spoiling. When exposed to sunshine, the first change is to a dull-brown, and if checked in this stage of the process

we get a negative picture; but if the action of the light is continued, the browning gives way and we have a positive yellow picture on a white ground. In either case, if the paper, when removed from the sunshine, is washed over with a solution of nitrate of silver, a very beautiful positive picture results. In practice, it will be found advantageous to allow the bleaching action to go on to some extent; the picture resulting from this will be clearer and more defined than that which is procured when the action is checked at the brown stage. To fix these pictures it is necessary to remove the nitrate of silver, which is done by washing in *pure* water; if the water contains any muriates, the picture suffers, and long soaking in such water obliterates it; or if a few grains of common salt are added to the water the apparent destruction is rapid. The picture is, however, capable of restoration; all that is necessary being to expose it to sunshine for a quarter of an hour, when it revives; but instead of it being of a red color, it becomes lilac, the shades of color depending upon the quantity of salt used to decompose the chromate of silver which forms the shadow parts of the picture. Mr. Bingham remarks on this process, that if we substitute sulphate of nickel for the sulphate of copper, the paper is more sensitive and the picture is more clearly developed by nitrate of silver. The following modification of this process possesses some advantages. If to a solution of the sulphate of copper we add a solution of the neutral chromate of potash, a very copious brown precipitate falls, which is a true chromate of copper. If this precipitate, after being well washed, is added to water acidulated with sulphuric acid, it is dissolved, and a dichromatic solution is formed, which, when spread upon paper, is of a pure yellow. A very short exposure of the paper washed with this solution is quite sufficient to discharge all the yellow from the paper, and give it perfect whiteness. If an engraving is to be copied, we proceed in the usual manner, and we may either bring out the picture by placing the paper in a solution of carbonate of soda or potash, by which all the shadows are represented by the chromate of copper, or by washing the paper with nitrate of silver. It may sometimes happen that, owing to deficient light, the photograph is darkened all over when the silver is applied; this color, by keeping, is gradually removed, and the picture comes out clear and sharp. If the chromate of copper is dissolved in ammonia, a beautiful green solution results, and if applied to papers they act similarly to those just described. The chromatype pictures, under certain conditions, afford a beautiful example of the changes which take place, slowly, in the dark, from the combined operations of the materials employed. If we take a chromatype picture after it has been developed by the agency of either nitrate of silver, or of mercury, and place it aside in the dark, it will be found, after a few weeks, to have darkened considerably both in the lights and shadows. This darkening slowly increases, until eventually the picture is obliterated beneath a film of metallic silver or mercury; but, while the picture has been fading out on one side, it has been developing itself on the other, and a very pleasing image is seen on the back. After some considerable time the metal on the front gives way again, the paper slowly whitens, and eventually the image is presented on both sides of the paper of equal intensity, in a good neutral tint upon a gray ground.

Chrome (Chromium). A metal consisting of a porous mass of agglutinated grains, very hard, brittle, and of a yellowish-white color and metallic lustre. Its texture is radiated. In its highest degree of oxidation it passes into the state of an acid, of a ruby-red color. It takes its name from the various and beautiful colors which its oxide and acid communicates to substances into whose composition it enters. Chrome has a powerful affinity for oxygen, and has been obtained in very small quantities only. It may be obtained by exposing the oxide of chromium, mixed with charcoal, to a very intense heat.

Chrome-Alum. Syn., Chromium-potassium sulphate. Prepared by passing sulphurous gas through a mixture of potassium bichromate and sulphuric acid. Also obtained as a by-product in the manufacture of alizarine. Occurs in dark-red crystals; soluble in 7 parts of water. Employed to toughen and render insoluble gelatine films. The following combination of chrome-alum is recommended by Dr. Higgins as a means of rendering dry plates insoluble, and permitting shorter washing by the use of warm water:

Take—

Chrome-Alum	¼ ounce.
Soda Sulphite (powdered)	1 "
Water	8 ounces.

Dissolve and pour into—

Hypo	½ pound.
Water	12 ounces.
(*No acid.*)	

Let the negative remain in bath some ten or more minutes after having become apparently fixed. It can then, if for any purpose desirable, be flushed freely at once with either warm, hot, or scalding water, without any slipping or softening of film. It should be remarked that it is well to be sure that the negative is of the right strength, not needing reduction, as it responds with difficulty to any subsequent treatment.

Chrome-alum is also recommended as an addition to the fixing bath in hot weather to prevent the frilling of gelatine plates. It is used also in carbon printing, photo-mechanical and emulsion work.

Chromated (or Bichromated) Gelatine. A mixture of gelatine solution and alkali bichromate. Exposed to light it becomes insoluble. On this are founded the carbon and most of the photo-mechanical processes.

Chromate of Potash. K_2CrO_4. A salt, soluble in water, not so in alcohol and ether. Used in bromide of silver gelatine for the removal of fog in negatives and in negative-retouching (gives a yellow inactinic color).

Chromates. Means chromic acid salts. These are sensitive to light, and are used, combined with organic reducers, in various photographic reproduction-processes.

Chromatic Aberration. (See *Aberration.*)

Chromic Acid. CrO_3. Beautiful red, deliquescent needles, soluble in water, at once decomposed by organic substances. It is prepared by decomposing the chromate of baryta with dilute sulphuric acid, adding the acid in sufficient quantity. It serves to dissolve the silver picture on a wet collodion plate, and to remove impurities (organic) from glass plates.

Chromo-Artotypy. A collographic process for obtaining prints in color, devised by E. Bierstadt, of New York. By this process a painting is copied by four negatives, representing the red, blue, and yellow colors, and a neutral tint, suitable color-screens being employed in the production of these negatives. From these collotype plates are made, and a print finally obtained, reproducing accurately the original painting copied.

Chromo-Collotypy. A process of collographic printing in colors, similar to chromolithography.

Chromo-Cyanotype. This process is based upon the changes which the bichromate of potash experiences with such facility beneath the influence of the chemical principle of the solar rays. It is the invention of Prof. R. Hunt.

Chromo-Photography. Crystoleum painting, crystal-ivorytype. Photographs mounted on glass, painted on the back, and made transparent.

Chromo-Phototype. This style of picture consists simply of the carbon process applied to the various colors, substituting blue, red, brown, or any other color in place of lampblack. The same picture may be printed in several colors by using a stencil for spreading the colors. First print a positive from your negative, and varnish it with shellac or other varnish, and when dry cut out the various parts for the different colors, leaving a slight space as a fringe, so that the part covering each space can be easily replaced. Raise one section, so cut, and apply the color in the same manner as in stencil painting; replace the section, raise another, and apply the proper color in the same way, and so on until all the colors you desire to introduce are in their required places on your paper. These colors must be first treated as for the carbon process.

Chromotype. A modification of the autotype (carbon) process.

Chrono-Photography means photographing the several motions and positions which a man or animal adopts in the different phases of walking, running, and jumping within equal portions of time, and upon an immovable sensitive plate.

Chrysaniline. $C_{20}H_{17}N_3$. Amorphous yellow powder, difficult of solution in water; very soluble in alcohol. Used in the preparation of color-sensitive plates, rendering them especially sensitive for green.

Chrysotype. A process invented by Herschel (1840–42) analogous to the cyanotype process. Paper is floated on a solution of ferric citrate of ammonium of such strength that when dry the paper looks yellow—not brown. After exposure the print is floated on a solution of neutral gold, diluted. This

solution can be applied with a brush, if desired. The image obtained is purple in tone, gaining in intensity the longer it is exposed to the solution. The print is then washed in several changes of water and fixed in a weak solution of iodide of potassium; washed again, and finally dried. From a positive drawing a print in white lines upon a purple ground is obtained.

Circular Composition. Illustrated by a drawing from Raphael. The first thing to be considered in a composition of this form is, where the point, that is, the spectator's eye, is to be placed; whether in the middle of the work or on one side, and so to determine its situation, that the important

FIG. 41.

figures be distinctly visible—not concealed by others. It is considered best to place those figures which are nearest to the point with their backs to the camera, and those further removed with their sides, etc., in perspective, as if a circle were drawn and figures were arranged around it.

Citrate of Iron. This salt is most conveniently formed by dissolving moist hydrated peroxide of iron in liquid citric acid, assisting the solution by heat. It must then be filtered, cooled, and spread very thinly on warm sheets of glass to dry, which it will rapidly do, and then may be detached from the glass in thin scales of great brilliancy and beauty. This beautiful salt is of a rich ruby color, almost tasteless, and slightly soluble in water. It is used photographically in the chrysotype and other processes, and in the toning bath. Five drops to the pint of any ordinary toning solution will increase the intensity and brilliancy of the shadows in the print.

Citrate of Iron and Ammonium. $Fe_2(C_6H_5O_7)2(NH_4)+H_2O$. Double salt, formed of ferric citrate and citrate of ammonium. Brown, shining leaflets. Used for blue prints (white lines on blue ground).

Citrate of Peroxide of Iron. $Fe_2(C_6H_5O_7)_2$. Thin, transparent, reddish scales, very soluble in water. Used in the preparation of paper for blue prints.

Citrate of Silver. Is formed by the union of oxide of silver and citric acid in the same manner as citrate of iron, and contains 3 atoms of oxide of silver to 1 atom of citric acid. When the citrate of silver is heated in a current of hydrogen gas, a part of the acid is liberated and the salt is reduced to a citrate of *suboxide* of silver, which is of a red color. The action of white light in reddening citrate of silver is of a similar nature. It is used in printing to give purple tones. Also in the preparation of gelatino-chloride of silver, collodio-chloride of silver, and to sensitize the prints in the toning bath. (Citrate of silver, *Printing Process.*)

Citrate of Soda. Abundantly found in commerce. It may be prepared by neutralizing citrate of lime with sulphate of soda. Sulphate of lime will be precipitated and citrate of soda remain in solution. Evaporate and crystallize.

Citric Acid. This acid is found abundantly in lemon and lime juice and in other fruits. To obtain it in crystalline form: take of lemon juice, 1 pint; prepared chalk, 1 ounce; dilute sulphuric acid, 6 fluidounces; distilled water, ½ pint. Add the chalk by degrees to the lemon juice, heat and mix; set aside, so that the powder may precipitate; afterward pour off the supernatant liquor. Wash the precipitate frequently with warm water; then pour upon it the dilute sulphuric acid and the distilled water and boil for fifteen minutes; press the liquor strongly through a linen cloth and filter it. Evaporate the filtered liquor with a gentle heat and set it aside to crystallize. To obtain pure crystals redissolve and evaporate two or three times, filtering each solution. Citric acid is used in photography in the developer in place of acetic acid, and in the same proportions. By some photographers it is considered superior for that purpose to acetic acid. It is also used in printing processes. In printing it is added either to the salting

solution, or to the ammonia-nitrate, or plain silver solution. When used in the salting solution the following formulas will be found good:

For Plain Silver Solution.

Salt	200 grains.
Citrate of Soda	200 "
Water	½ gallon.

For Ammonia-Nitrate Solution.

Salt	90 grains.
Citrate of Soda	50 "
Water	½ gallon.

When used in the ammonia-nitrate of silver solution and not in the salting, one drop of a 40-grain solution of the acid to each ounce of the ammonia-nitrate solution may be added.

Citric acid, used in the iron developer, prevents turbidity of the iron solution and fog, and in pyrogallic and hydroquinone developers as a preservative. In the preparation of bromide of silver and gelatino-chloride of silver emulsion, as also in the preparation of durable sensitized albumen paper, it is also employed.

Clay Surface Process. Syn., Kaolatype. Used to quickly prepare line printing blocks for newspapers, etc. A metal plate is coated with a composition of pipe or china clay, and on this surface, when dry, the drawing is cut with hooked-shaped tools down to the surface of the plate. A stereotype (metal cast) of the plate is now made, which furnishes the printing block for the press. Plates prepared as above may be obtained commercially.

Cleaning Fluid. A very good mixture for cleaning either the daguerrotype or glass plate. Take 40 drops of petroleum (rock oil), 1 ounce sulphuric acid, and 5 ounces alcohol; mix and filter. With this make a paste with rottenstone about the thickness of cream.

Cleaning the Glass. The first process in making a negative and one of considerable importance to the final result, for unless the glass is properly and thoroughly cleaned, spots and streaks will occur and the collodion film will peel off. (See *Albumenizing.*)

Cleaning the Plate. The first process in the art of daguerrotyping. The methods of arriving at the desired result are various, according to the taste and inclination of the operator.

Clearing Bath. A solution of alum and citric acid in water, for removing spots and yellow discoloration in negatives.

Clearing Solution. The name given to any solution which clears a negative or positive of stains or veiling. For collodion negatives a weak solution of cyanide of potassium is advised—30 grains to one ounce of water.

To clear *collodion slides* or *transparencies* a few drops of a solution of 20 grains of iodine in one ounce of alcohol, added to half an ounce of water, is advised.

For clearing *gelatine negatives* the following formula gives good results:

Chrome Alum	1 ounce.
Citric Acid	1 "
Water	20 ounces.

Mr. John Carbutt recommends:

Chrome Alum	½ ounce.
Citric Acid	½ "
Water	30 fluidounces.

The negative is immersed in this after being developed and washed, before fixation.

The name of "Clearing Solution" is also given to a saturated solution of hyposulphite of soda in water for fixing the negative on glass, and clearing it of the unchanged iodide of silver.

Clearness. Absence of veil or fog in negatives or prints.

Cliche. A name given to the negative, or collotype plate, or to the photo-relief block used in printing.

Clips. Clasps; American clothes clips. Small wooden clothes "pins" used to hold paper while hanging up to dry.

Closson's Process. A secret substitution process for producing intaglio or relief printing plates without the use of photography, invented by W. R. Closson. The work in this process being entirely hand-done, the artist may perfectly express his individuality as in painting or etching.

Cloth, Transferring. (See *Transfer Cloth.*)

Cloud-Catcher, Norton's. An instantaneous shutter provided with adjustable disks, by means of which the foreground may be exposed sufficiently while the sky may be taken instantaneously, thus giving every portion of the sensitive plate sufficient time for full exposure. (Fig 42.)

Cloud Stop. A diaphragm which retards the actinic effect of the sky in landscapes, which otherwise would be over-exposed as

compared with the foreground. A shutter, specially constructed for the same purpose, is mostly used now.

FIG. 42.

Coagulated. Concreted; curdled.

Coagulated Albumen. White of egg which, by some means (for instance, by heating), has lost its original solubility in water.

Coagulation. The act of changing from a fluid to a fixed state; the state of being coagulated; the body formed by coagulating.

Coalesce. To come together; to grow together; to unite by natural affinity or attraction.

Coalescence. The act of growing or coming together; the act of uniting by natural affinity or attraction; the state of being united.

Coal Tar Colors are utilized in photographic printing in the diazotype and primuline processes, introduced in 1891-92. These processes may be studied under their respective headings.

Coating Box. A box for the purpose of giving the daguerrean plate its sensitive coating.

Coating the Glass Plate. The first operation in the *negative or ambrotype processes.* After cleaning the glass thoroughly, take it between the thumb and forefinger, by the left-hand lower corner, or rest it on the ends of the fingers and thumb of the left hand at the centre. Pour on the upper left-hand corner sufficient of the iodized collodion to flow freely and cover the whole plate evenly; tilt the plate so that the collodion will run briskly and evenly to the right-hand upper corner, and then to the left-hand lower corner and from that to the lower right-hand corner, where the excess of collodion must be poured off into your collodion bottle. This must be executed with sufficient rapidity to prevent the film from *setting* at the upper portion before the excess is got rid of, otherwise an uneven surface will result, and fogging be the consequence in the nitrate bath, in that portion which will become dry before the lower portion has "set." Hold the plate horizontal a few seconds, or until the film is quite "set" (but not dry), which may be ascertained by touching the edge of the film with the end of the finger; if sufficiently set, but a slight impression of the finger will be left on the film. It should not be, however, so dry as to leave no impression. This operation can be performed in the light, but the rest of the process must take place in the dark-room.

Coating the Plate. The second operation in the daguerrotype process and designed to give sensibility to the plate.

Cobalt Printing. The photographic properties of the salts of cobalt have only recently been studied, and are, therefore, as yet imperfectly known. Messrs. Lumière Bros. report that hydrated peroxide of cobalt, dissolved in oxalic acid, gives a solution of very unstable cobaltic oxalate, which is easily reduced to the cobaltous state by the action of light. This action may be utilized to produce photographic prints.

M. Reders, after trying the sulphate, nitrate, and chloride of cobalt for toning photographic prints, suggests the use of the chloride. The formulæ which have so far appeared require complicated treatment, and the method cannot be said to be practicable as yet.

Cocking the Camera. A term applied to the depression of the nozzle of the camera from the horizontal line, in order to take in the lower portion of a figure, or more of the foreground in a landscape. It is a bad plan in most cases; as a rule, the centre of the object should be in a direct line with the centre of the lens and of the spectrum.

Cohesion. Cohesive attraction; hanging together of the smallest particles of homo geneous substances.

Coincidence. If a ray of light falls on a parallel piece of glass, A (Fig. 43), perpendicularly, it will pass through it in a right line, because it is coincident with the normal. But if a ray, R, strikes the glass obliquely,

it will be refracted toward the normal, N, and away from it when leaving it. As the normal N and N′ are parallel, so must the incident and refracted ray be after leaving the glass. Now let us see another case, where the two surfaces are not parallel, but form an angle with each other. Such a medium

Fig. 43.

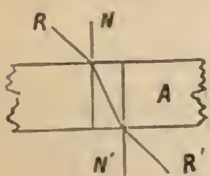
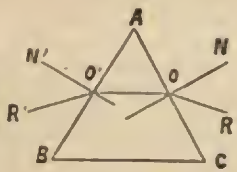


Fig. 44.



is called a prism. R o (Fig. 44) is an incident ray; the ray is refracted toward the normal, N, along o o′, and by leaving the prism it is again refracted, but this time from its normal, N, as it passes from a denser to a rarer medium. Therefore, incident rays on a face of a prism are always refracted toward the base.

Cold Varnish. (See *Varnishes.*)

Collodio-Albumen. A preparation of collodion and albumen, formed by either mixing together, or by first coating the glass plate with a film of collodion and afterward with one of prepared albumen.

Collodio-Albumen Process. This process, which combines the use of collodion and albumen, was first introduced by M. Taupenot, of France, in whose honor it was named the "Taupenot Dry Process;" the original formula is therefore placed in this work under that head. Many modifications of the process have been made, mostly bearing the names of their inventors, and are, therefore, to be found under such heads. The collodio-albumen process, so called, in most general use, although not superior to many others herein given, is as follows: The glass is to be cleaned in the usual way (see *Cleaning the Glass*), and then *coated* with the collodion as directed for the ordinary collodion process. Choose a rather thin collodion which adheres tightly to the glass, and in iodized after *any* given formula. As a rule, a non-contractile, structureless collodion is best. Allow it full time to set before putting it in the nitrate bath, in order to favor its adherence to the glass. The *nitrate bath* is made of:

Fused Nitrate of Silver . . .	40 grains.
Glacial Acetic Acid . . .	30 minims.
Alcohol	20 "
Water	1 fluidounce.

Saturate with iodide of silver, and filter.

An immersion of one minute will be sufficient; after which give the plate an up-and-down movement, and wash it well with water. Stand it up to drain for one or two minutes; wipe the back of the glass and pour on the albumen. This bath may become discolored after a time; continue to use it until it is of a dark sherry color, and then treat it with kaolin.

The Iodized Albumen. Procure eggs fresh laid; separate the whites and prepare in the same way as for *albumen paper* (omitting the salt) and mix by the following formula:

Albumen	9 fluidounces.
Water	3 "
Liquor Ammonia . .	2 fluiddrachms.
Iodide of Potassium .	48 grains.
Bromide of Potassium .	12 "

The iodide and bromide should be free from carbonate of potash, which causes pinholes in the negatives. To insure the absence of this salt, dissolve the total quantity of both iodide and bromide in the three ounces of water advised in the formula; then, previously to adding the ammonia and albumen, introduce an *excessively minute particle of iodine*, enough barely to color the liquid. The iodine decomposes the carbonate of potash, but it must not be used in excess, since free iodine possesses the property of coagulating albumen. Having mixed the ingredients in the order above given, shake violently until they have thoroughly amalgamated. Then transfer to a tall, narrow jar; allow to settle twenty-four hours, and draw off the upper clear portion for use. This solution of albumen may be kept for some time in a stoppered bottle without much decomposition. If mucous threads form in it, filter through fine linen. Apply it to the collodionized glass in the manner described for the *albumen process*, and stand it upon blotting-paper to dry. When thoroughly dry plunge it into the nitrate bath for one minute, then wash with water as before, but with greater care, in order to prevent clouding in the development. If blisters should form on drying, it will be found useful to hasten the process by holding the plate to the fire, or a hot iron may be placed in the centre of a covered box and the glasses

reared up around it. They will thus dry quickly, and there will not be time for the albumen to swell much by imbibition. Of course, all this must be done in a dark-room.

Exposure in the Camera. This may be performed at any period within a few weeks from the date of preparation of the plates. For a landscape view with a small stereoscopic single lens, allow about three minutes in the winter, or one and a half in the summer.

Development of the Image. This can be deferred as long as fourteen days after the exposure. Pour water over the plate until the film is thoroughly wetted; then cover it with a solution of pyrogallic acid, containing one grain of the acid to one ounce of water and twenty minims of glacial acetic acid. Two drops of a neutral solution of nitrate of silver made with forty grains of nitrate to the ounce of water must be previously added to each drachm of pyrogallic acid. The development, in case of a landscape view taken with sunlight, commences almost immediately and may be completed in about ten minutes, but the time occupied in developing will vary greatly with the length of exposure, the quantity of nitrate of silver, and the nature of the subject copied—a badly lighted interior, for instance, often taking an hour or longer to appear in all its details. If the developer should discolor before the proper degree of intensity is obtained, pour it off and mix a fresh quantity.

Fixing the Image. Hyposulphite of soda (one ounce to four of water) will be found preferable to cyanide of potassium, as the latter has a solvent effect upon the albumen. An unusually long time will be required, as the fixing agent must penetrate the albumen to reach the collodion beneath. Careful washing in water for five or ten minutes removes the excess of hyposulphite, and the plate may then be varnished (after drying) in the usual way.

Collodion. M. Le Gray was the first to suggest the application of collodion to photography, but Mr. Archer was the first who successfully applied it, and in 1851 published a treatise on his process. Collodion is a solution of gun-cotton, or pyroxylin, in alcohol and ether, and is prepared in various ways. The usual formula is:

Pyroxylin	3 to 5 grains.
Ether	5 fluidounces.
Alcohol	3 "

If the ether is in large excess, the film is inclined to be strong and tough, often so as to be raised by one corner and lifted completely off the plate without tearing. It is also very contractile, so that a portion of the collodion poured on the hand draws together and puckers the skin as it dries. If spread upon a glass plate the same property of contractility causes it to retract and separate from the sides of the glass. These properties, produced by ether in large proportions, disappear entirely on the addition of alcohol. The transparent layer is now soft and easily torn, possessing but little coherency. It adheres to the surface of the glass more firmly, and exhibits no tendency to contract and separate from the sides. The physical properties of collodion are affected by another cause, viz., by the strength and purity of the solvents, or in other words, their freedom from dilution with water. If a few drops of water be purposely added to a sample of collodion, the effect is seen to be to precipitate the pyroxylin in flakes to the bottom of the bottle. The manner in which water gains entrance into the photographic collodion is usually by the employment of alcohol which has not been highly rectified. In that case the collodion is thicker and flows less readily than if the alcohol were stronger. Sometimes the texture of the film left upon evaporation is injured; it is no longer homogeneous and transparent, but semi-opaque, reticulated, or honeycombed, and so rotten that a stream of water projected upon the plate washes it away. These effects are to be attributed not to the alcohol, but to the water introduced with it; and the remedy will be to procure a stronger spirit, or, if that cannot be done, to increase the amount of ether. Collodion prepared with a large proportion of ether and water, but a small quantity of alcohol, is often very fluid and structureless at first, adhering to the glass with some tenacity, and having a short texture; but it tends to become rotten when used to coat many plates successively—the water, on account of its lesser volatility, accumulating in injurious quantity in the last proportions. The physical properties of collodion are also affected by the character of the pyroxylin. A low temperature in preparing the pyroxylin favors the production of a contractile collodion; whilst, on the other hand, a hot nitro-sulphuric acid tends to produce a short and non-contractile collodion. (See also

Alcoholic Collodion, *Iodized Collodion* and *Collodion Negative Process*.)

Collodion Accelerator. Any substance capable of giving sensitiveness to the collodion film. Besides the substances and formulas given in the various processes to be found in this work, the acetate of soda may be used. Four grains of dry acetate of soda, and four grains of iodide of cadmium to the ounce of collodion, will give a strong impression in about the ninth part of the time of ordinary collodion, and is quite free from any symptoms of fogging. Collodion so prepared, however, will not keep more than a few hours.

Collodion, Acidity of. (See *Acidity of Collodion*.)

Collodion, Alcoholic. (See *Alcoholic Collodion*.)

Collodion, Alkaline. (See *Alkalinity of Collodion*.)

Collodion Bottle. A bottle or vial, deep, narrow, and wide-mouthed, from which the collodion is poured upon the plate. The "cometless" collodion bottle is a neat and useful invention for this purpose.

Collodion Filter. A useful apparatus, consisting of three principal parts or pieces blown from glass, viz.: a pear-shaped funnel, a balloon-shaped reservoir for the filtered collodion, and a cylinder-shaped reservoir for unfiltered collodion at the bottom. The parts of the apparatus are carefully adjusted to each other, and fitted air-tight by being ground or by suitable packing. The operation of the filtering will now be readily understood. The collodion is introduced in the opening at the top of the apparatus, passes down the funnel tube to the lower reservoir, upward, through the filter, into the balloon, from which it may be drawn off by the stopcock. The air in the pear-shaped funnel is connected with the air in the balloon by means of a tube of glass or vulcanized rubber, in order to equalize the pressure. The advantages of this method of filtering are that, inasmuch as the liquid passes upward through the filter, the filter will not so easily get foul, and that the whole liquid being confined, nothing will be lost. (See *Filtering Apparatus*.)

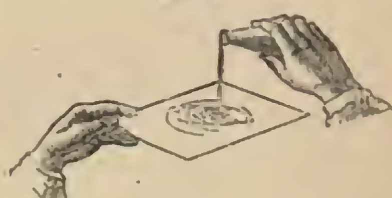
Collodion-Gelatinized Paper. A paper, introduced by M. Gerard, for printing photographic positives. He considers it superior in every respect to albumen or plain paper. The following is the process of manufacture: Into a bottle containing 5 drachms each of alcohol and ether, drop gradually a saturated solution of chloride of ammonia until a flocculent precipitate is produced; shake well and filter; add this liquid to a collodion thus prepared:

Ether	3½ ounces.
Alcohol	5 drachms.
Pyroxylin	38 grains

Pour this mixture upon a glass plate and immerse in water containing 2 per cent. of salt, until all greasiness disappears. While in this bath, take a sheet of paper, gelatinized by a solution containing 2 per cent. of gelatine and 1 per cent. of chloride of ammonium, and make it adhere to the paper. Remove the whole from the bath and allow it to dry. To use this paper, remove it from the glass by means of a bath of distilled water, then blot off by paper kept especially for this purpose, and place the sheets, still slightly damp, upon the nitrate bath in the ordinary manner. Remove and blot in another portion of the blotting-paper, and dry. Tone and fix in the usual manner. The paper may be kept in a portfolio after removal from the glass; but it will, in that case, be necessary to immerse it in distilled water for some minutes, so as to moisten it previous to its exposure on the nitrate bath.

Collodionizing. A manipulation in wet-plate photography whereby the plate is coated with collodion. The plate is seized between the thumb and fingers of the left

FIG. 45.



hand at the left lower corner, raising it sufficiently to permit the eye to scan its whole surface, holding it perfectly level. Pour out upon it a small oval puddle of collodion, say sufficient to cover two-thirds of the glass surface. Rock the plate gently so as to cover it wholly while flowing toward the right lower corner, whence returning the surplus to the collodion pourer.

Collodion Negative Process. This process consists in covering a glass plate with a film of sensitized collodion, and impressing upon it a picture, the character of which is the reverse of the natural object. The formulas for this process are very numerous, many of which will be described under their appropriate heads, as they all derive their names from those of their inventors. We shall, however, here give the process generally practised in America, and which undoubtedly is an excellent one. (For cleaning and coating of the glass plate see *Cleaning the Glass and Coating the Glass Plate*). To make the collodion, take—

Alcohol 95°	8 ounces.
Conc. Sulph. Ether	8 "
Pyroxylin	80 grains.
Iodine with Iodide of Potassium	80 "
Bromide of Potassium	16 "

Thoroughly dissolve in the alcohol. Stand it aside for three or four days to settle, and then pour off the clear portion into a clean bottle, or filter. Make the *nitrate bath* with 40 grains of nitrate of silver to the ounce of water, saturate with iodide of silver, and add just sufficient glacial acetic acid to barely change blue litmus paper to a very light red. Immerse the plate in this bath for three or four minutes, churning it up and down occasionally. When the plate is put into the bath, it must be done quickly, with one steady plunge, otherwise it will be streaked; but in taking it out, the slower the movement the less it will drip, and the greater the economy of solution. The churning prevents those little pin-holes so often annoying to the operator. If they occur, however, notwithstanding this precaution, the solution must be put into a bottle and exposed to the light for a day and filtered. As the solution weakens, add crystals of nitrate of silver and filter, or keep a stock-bottle of a 40-grain solution to be added to the bath as required. When sufficiently sensitized, the film will present a rich creamy appearance. Expose in the camera the necessary time and develop with—

Protosulphate of Iron	1 ounce.
Acetic Acid	2 ounces.
Alcohol	1 ounce.
Water	16 ounces.

Flow this over the plate quickly and without stoppage, and agitate until the picture is fully brought out, in which case it will be, in the shadows, of a vigorous brown, the lights clear and transparent. Wash off thoroughly under a stream of water and place it, film upward, in a saturated solution of hyposulphite of soda. When the unchanged silver is all dissolved out, wash again for eight or ten minutes and stand up on one corner to dry. When thoroughly dry, slightly warm the plate and pour over the film any *one* of the negative varnishes described in this work; let it dry, and the negative is ready to print from. If the negative is not sufficiently vigorous or intense after this development, it may be intensified, after fixing and before drying, by either of the methods described in articles *Bi-Chloride of Mercury, Intensifying*, and *Re-developing*. (See *Negative Collodion*, INDEX.)

Collodion Positive Process. (See *Ambrotype*.) In addition to the formula there given, we may add the following as giving the best results: Put 12 ounces of sulphuric ether and 8 ounces 95° alcohol in a bottle, and add to it 42 grains of gun-cotton; shake frequently, to facilitate solution. Let it stand for a few days to settle, then pour off the clear portion. The iodizing solution is made as follows:

1. Iodide of Cadmium	14 grains.
Alcohol	1 ounce.
Dissolve and filter.	
2. Iodine	6 grains.
Alcohol	1 ounce.
Dissolve and filter.	
3. Bromide of Cadmium	30 grains.
Alcohol	1 ounce.
Dissolve and filter.	

4. Make a saturated solution of common salt in water.

To iodize the collodion, pour 1½ ounces of the latter into a perfectly clean bottle, add to it ¼ ounce solution No. 1, and shake well together; then add 10 drops of No. 2, and 20 drops No. 3; shake well and stand it aside for a few hours, and add 12 drops solution No. 4; let it stand for a few days and it is ready for use. This collodion gives beautiful pictures and keeps for a long time. The *nitrate bath* is made of nitrate of silver, 30 grains to 1 ounce of water, and should be slightly acid. Having coated the plate (see *Coating the Plate*), immerse it in the bath for one minute only in moderately warm weather, a little longer in winter. The plate should then be moved up and down in the

bath several times before taking it out. To *develop* the picture take—

Protosulphate of Iron	½ ounce.
Water	5 ounces.
Glacial Acetic Acid	8 drops.
Nitric Acid	2 "
Alcohol	1 drachm.

Dissolve and filter. Fix with cyanide of potassium, 10 grains to the ounce of water.

Collodio-Bromide. Collodion containing bromide of silver suspended in such fine division as to form an emulsion which, to the naked eye, shows no granulation or small particles. Used for collodion dry plates.

Collodio-Chloride Print-out Paper. The collodio-chloride print-out process, by which the commercial Aristo collodion papers are prepared, originated with G. Wharton Simpson, in 1864 or 1865. It consists in coating a gelatinized or baryta-surfaced paper with an emulsion of silver chloride in suspension in collodion. Collodio-chloride papers are printed by contact in the usual way, and are said to give more delicate images, with added brilliancy, than albumen paper. As a rule, collodio-chloride paper requires printing somewhat deeper than albumen paper, and more care is desirable in manipulation than with other papers, on account of the delicate nature of the film. The prints may be either toned and fixed as usual, or partly printed and afterward developed to the required color and strength.

Collodio-chloride emulsion may also be coated upon opal, china, watch-dials, as upon paper, and very fine pictures may be thus produced. An emulsion formula for these purposes will be given under *Emulsions* (q.v.), but the reader will profit by using the commercial paper, on account of its reliability and uniformity of strength and coating

Collodion Dry-Plate Process, with bath. A process no longer practised, in which a collodionized plate was sensitized in the silver bath, then washed in distilled water and flowed with a substance that would neither dry nor crystallize (white of egg, gelatine, tannin, coffee, tea, gum, etc.). Plates so prepared would keep some time, but were much less sensitive than wet collodion plates.

Collodion Positives on Black Leather. This process is accomplished by coating the leather with collodion in the same manner as for glass. To sink the leather in the nitrate bath, use a gutta-percha dipper turned up at the end, and at the proper distance from the end insert a piece of slightly curved silver wire through the dipper; this, when turned down, holds the leather tight in its place; then, to prevent the spring in the dark slide from making the prepared side convex, place a piece of glass of the same size upon the back of the leather. It is advisable to coat the leather with two or three dressings of black varnish on the back and edges, to prevent any organic matter the leather might contain from spoiling the bath. It also helps to stiffen it. The only cleaning required is rubbing with wash-leather.

Collodion Transfer. An enlarged transparency upon glass backed by a lithographic or other design. In making these, the principle is just the same as with a reflecting

FIG. 46.

solar camera, without the reflector or condenser. The drawing will help to explain. The box should be about 15 inches square and 18 inches long. F is a board 15 inches wide and 5 feet long, to which the box is fastened; A is the easel, which slides on the board to or from the lens, according to the size of the enlargement; B is a rod of wood (or iron is better), which is fastened to the carrier, inside the box, into which slide the negative. Focus (after the easel is far enough away to give the desired size) by removing the negative-rack, by means of the rod B, to or from the lens inside, until the image is sharp on the glass; cover with white paper, placed on a ledge on the easel; remove this glass, and place the sensitized paper plate in the same place, and time about one minute, or according to the density of the

negative; of course, there must be no white light in the room. Any bath and collodion that works clear in the shadows will do; the collodion should be old, and the bath quite acid; the bath must be as weak as it will work with the collodion—we get the best results with about a 25-grain bath. The developer must be pyro; a good one is as follows: Water, 1 ounce; pyrogallic acid, 5 grains; citric acid, 3 grains; acetic acid, ½ drachm; alcohol, if necessary to make it flow smoothly. The positive should be timed so as to develop quite slowly; do not develop too far, or the whites will not be clear. It is not necessary to wash it after developing; place in hypo and let it fix; then wash thoroughly. Be careful, for otherwise the film will loosen, the plate not being albumenized. These pictures should be colored to be effective.

Collodion Varnish. A glutinous solution of gun-cotton in alcohol and ether; the alcohol largely in excess.

Collodion Wet Plate. A negative process in which a glass plate, coated with collodio-iodide of silver and still wet from the silver bath, is exposed in the camera and then developed by a sulphate of iron solution.

Collodiotype. Any photographic picture made by the collodion process, on glass or other substance.

Collodio-Waxed-Paper Process. This is a negative process, to be accomplished in the following manner: Take a sheet of photographic paper, free from spots and defects, and, before waxing it, submit it to either of the following modes of treatment:

(*a*) Immerse it for half an hour in a dilute solution of muriatic acid, say one part of acid to three of water. This removes any metallic spots and softens the size, so that the paper imbibes the wax uniformly and without granulation, which is a very important point. Then wash it in several changes of water and hang it up to dry. In doing this be very careful, for the paper is extremely tender.

(*b*) Soak the paper in boiling water, in order to soften the size and enable it to take the wax without showing granulation. Dry it as before, very carefully.

The next operation is to wax and iron the paper in the ordinary way. (See *Waxed Paper*.) Having thus prepared the waxed paper, it must be cut about half an inch smaller every way than the glass plate, which fits the dark slide used in the collodion process. Then brush it over, on both sides, with absolute alcohol, and apply it immediately to the glass plate, pressing it into close contact by means of a camel's-hair brush. The collodion is then to be poured upon the paper, precisely in the same way as upon a glass plate. The entire plate must be coated up to the edges of the glass; the outer border of the collodion then protects the back of the paper from the action of the chemicals, and fastens it firmly to the glass. The paper is sensitized, exposed, developed, and fixed in the same way as the glass negative. It is then removed from the glass, allowed to soak in water four or five hours and hung up to dry, and afterward ironed out flat for printing purposes.

Collodiumwolle. Pyroxylin. Cotton, free from grease, treated with a mixture of sulphuric and nitric acid in equal volumes. Makes, dissolved in ether and alcohol, collodion. Differs from gun-cotton in being less explosive. It is soluble in ether and alcohol.

Collographic Processes. Under this general name are included all the modifications of the collotype process, such as Albertype, heliotype, photo-gelatine process, artotype, phototype, lichtdruck, etc.

Colophony (resin). A solid residue left after the distillation of turpentine, yellowish and translucent, giving a light-yellow powder. Soluble in alcohol and ethereal oils. Used in the preparation of varnishes and of a resin-emulsion (v. Harzseifen), for a matt positive paper (Valenta), and for graining in mechanical processes.

Collotype. A process for producing positive impressions on paper in a hand-press (Schnellpresse), from glass plates, coated with chromgelatine, exposed under a negative, washed and rolled in with fatty ink. The process was perfected by Joseph Albert in Munich. (See *Albertype*.)

Color. A property inherent in light, which, by a difference in the rays, and the laws of refraction, or some other causes, gives to bodies particular appearances to the eye. The principal colors are *red*, *blue*, *yellow*, and *indigo*, from which four, by their admixture in various proportions, all the other colors are derived. White is not properly a color, as white bodies reflect the rays of light without separating them. Black bodies, on the

contrary, absorb all the rays, or nearly all, therefore black is not a distinct color. The type of color is found in the prismatic spectrum, in which we discover that a ray of white light is capable of being decomposed into three *primitive* colors, *red*, *blue*, and *yellow*; these by their mixture produce three others, which are termed *secondary*. Every hue and tint in Nature is produced by the mixture of two or more of the primitive colors in various proportions; thus red and yellow produce orange; blue and red, purple; yellow and blue, green, etc. Grays and browns are composed of all three of the primitive colors in unequal proportions. Black is the result of a mixture of blue, red, and yellow, of equal intensity and proportions. Of material colors, there is but one (ultramarine) that approaches the type in the spectrum—all the others are more or less impure; thus we cannot obtain a pure red pigment, since all are more or less alloyed with blue or yellow. If we could obtain a red and yellow of the same purity and transparency as ultramarine, we should need no other pigments for our palette, since, by judicious mixture, they would yield every tint in nature. *Local colors* are those peculiar to each individual object, and serve to distinguish them from each other. *Complementary colors* are composed of the *opposites* of any given color. If this color is primitive, such as blue, the complementary color is composed of the other two primitive colors, viz., red and yellow, or orange; the complementary color to any *secondary* is the other primitive color; thus, the complementary of green (composed of yellow and blue) is red, and so on for the remainder. *Harmony of color* results from an equal distribution of the three primary colors, either pure or compounded with each other, as grays and browns. *Contrast of color* is either simple or compound. Each of the primitive colors forms a contrast to the other two; thus blue is contrasted by yellow and by red—either of these forms a simple contrast to blue; but by mixing yellow and red together, we produce orange, which is a *compound* contrast, consequently orange, the *complementary* color, is the most powerful contrast that can be made to blue. Colors are regarded as warm or cold, positive or negative; thus blue is a *cold*, and orange a *warm* color. Red is neither warm nor cold. All warm colors are contrasts to cold colors.

Color-Box. All careful artists keep their colors and pencils in a box made for the purpose. The form and size of the box may be made to suit the taste and means of the artist, and may contain from three to sixteen colors and tints.

Colored Glasses in Printing. The question of the advantage of printing through colored glass has recently been revived, and it is claimed that increased vigor is given to prints obtained in this way. Aristotype and albumen papers are well adapted for this method of printing, and it has special reference to weak negatives. Mr. Bridge, an English worker, has employed since 1873 sheets of gelatine colored green or pale red for printing from weak negatives in the shade, and obtains by this procedure more delicate detail and finer tone than by the ordinary method. For negatives of ordinary density light-green or green-blue glass is advised. By the use of a peacock-green glass, the ultra-violet rays, and a good deal of the violet are cut off, and the blue and green rays pass freely through the negative, which rays actively affect the albuminate of silver in the paper, giving more effective gradation in the print. This method would seem especially applicable to the soft and under-intense negatives now used for the various Aristotype papers.

Colorific. The property of giving color to bodies.

Colorific Rays. The rays of light possessing the power of imparting color to bodies.

Coloring. This term is justly applied to the use of colors on the daguerrotype and ambrotype, and in the hands of most photographers fully expresses its meaning, as it improves them—generally speaking—about as much as the same process in the hands of unskilful girls does a fine steel engraving.

Coloring Glass Positives or Ambrotypes. Practical instruction alone can accomplish anything in teaching this branch of the art. The dry colors should be used, put on with a fine sable pencil. Touch-in each color in its appropriate place, occasionally blowing off the loose particles and going over again, until the required tint is obtained. If by this means sufficient depth of color is not obtained, varnish the picture with amber dissolved in chloroform, and go over your picture a second time wherever it requires more color, and fix this second layer of color

with the vapor from your varnish bottle, by holding the picture over the mouth of your bottle. Care must be taken not to let any of the liquid get upon the picture. If after this the color is still not deep enough, repeat the operation.

Coloring Photographs. Formerly the demand for tinted and colored photographs was considerable; to-day, however, it can hardly be said to exist. The operation of properly coloring a photograph is a matter of experience and skill, and can hardly be taught by books. Those who are unable to secure personal instruction will find full particulars in the manuals.

Coloring Photographs in Oil. The same remarks applied to coloring positives on glass are equally pertinent to this branch of the art, with greater force; and as it would require much more space than a work of this kind will allow to give the necessary instructions to lead to its practice, we must refer the reader to the appropriate works on the art of painting. There are several styles of colored photographs which have been from time to time introduced, which may be produced by anyone of taste after some practice.

Colorocalotype. This process was introduced by Mr. Brinckerhoff, and is analogous to the Hallotype, Minotto's process, and others. The photograph is laid face downward upon a glass plate with a varnish of gum damar dissolved in turpentine or benzole; a duplicate is then colored and laid upon the back of the first while still wet and fixed there by a stout piece of cardboard. Care must be taken that the corresponding parts of each picture match perfectly, or the effect will be destroyed.

Color of the Negative Film. This varies with the developer used, and influences considerably the time occupied in printing and the quality of the print obtained. The modern developers, such as metol, amidol, etc., give gray-black negatives which print well and quickly; pyro-soda and ferrous oxalate give greenish-gray images which print rapidly and give excellent prints. Yellow- or red-stained negatives print slowly and give harsh prints with lack of gradation. The best printing color is the olive-greenish-black secured by the use of pyro and ammonia.

Colors, Photography in Natural. (See *Heliochromy.*)

Colors, Photography of. (See *Orthochromatic Photography.*)

Coma. A nuisance occurring only in single lenses; in reality nothing else than spherical aberration. It shows itself when rays inclined toward its axis pass through the lens, and may be obviated by using a small diaphragm. The tail formation characteristic of the coma, results almost invariably from astigmatism.

Combination-Printing. A mode of printing by which the positive is obtained by the help of two or more negatives. In printing from the first negative, those places which are to be obtained through the second, are stopped out, and when printing from the second negative, the parts already printed are protected. It is made use of when a portrait is to have a different background, or clouds are required in a landscape with white sky, etc. The simplest form of combination-printing is the combining of a separate cloud negative with a cloudless landscape negative, to produce a print of the landscape with cloud effects as if the whole had been secured with one exposure. Similarly, groups of persons can be combined in one print from separate negatives of each person, a suitable background being required as the basis; or figures may be inserted in landscapes as required, etc. The usual method of procedure is to carefully block out in the original negative the space required for the insertion of the figure, clouds, etc., and having obtained a print in this way, to print in the detail from a second negative in which only the figure (or clouds) is allowed to impression the print. Care and patience are required for this work, by which beautiful and interesting results may be obtained.

Combination Set. The union of several lens-pairs of different foci, all fitting into one thread-ring or flange, making it possible, with proper combination of the lenses, to photograph objects of the same size at differing distances, or of differing sizes at the same distance.

Combined Toning and Fixing Bath. A bath containing both chloride of gold and hyposulphite of soda in solution, so as to tone and fix at the same time. Usually it also contains alum, to harden the pictures; sulpho-cyanide of ammonia, to obviate the inclination of the prints to tone the half-lights quicker than the shadows, also to increase their permanency; and a lead salt to quicken the toning by the formation of silver sulphide.

Cometary Photography. The first attempts to photograph a comet were made by De la Rue, in 1858, when an unsuccessful effort was made to photograph Donati's comet of that year. After 1881, dry plates being available, Common, Draper, Huggins, and Janssen obtained excellent negatives of comets. One of the best comet photographs so far secured is that of Finlay's comet in 1882, by Dr. Gill, at the Cape of Good Hope.

Compensator. In a general sense, a (yellow) glass plate (screen) used in exposures of color-sensitive plates; in particular, an optical arrangement, by A. Miethe, intended, like the star diaphragms (but is more perfect) to suppress or weaken the rays passing through the centre of an objective, till their intensity or force becomes like that of the rays passing unobstructed through the edges of the lens. It consists of two very thin lenses, one made out of smoke-glass (Rauch-glass) and plano-convex, the other, colorless and equally plano-convex. These are cemented so as to form a plate, flat on both sides, and gradually becoming darker toward the middle. It is placed before or behind the objective. It necessitates an exposure three times longer than usual.

Composite Portraiture. A method of portraiture, devised by Francis Galton (1878-1881), in which a series of portraits of different persons is combined by super-imposition either on the plate or in the print, so that the accidental variations of the individuals are eliminated, and a "generic picture" of the series is obtained. This idea of combining several pictures in one to obtain a typical portrait of a series had previously occurred to Herbert Spencer and others; to Galton, however, we owe the study and elaboration of this interesting question. Of the many ways by which composite portraits may be obtained, Galton determined that the most satisfactory method was to obtain the composite image upon the plate in the camera, by successive fractional exposures of the several subjects, the resulting negative to be blended by after-treatment before printing. Galton observes that if a series of negatives of a child, obtained at the rate of one each year, were to be combined after the lapse of years in one negative by reproduction, the result would be a most interesting study of the evolution of the family type. The full face or perfect profile pose is recommended as the best for this purpose, the negatives being lighted as far as possible alike. In the blending of the composite portrait, the pencil of the retoucher may be effectively employed to tone down obtrusive peculiarities, etc.

Compound. To unite or mix two or more substances together; a mixture of two or more ingredients.

Compound Stereoscope. This invention, of M. Czugajewicz, consists of a compound stereoscope in which general or panoramic views of streets, the banks of rivers, and coast-lines, monuments, sea views, etc., may be displayed by means of the gradual unrolling of one or more endless slides or bands carrying pictures. It is immaterial whether the pictures represent one side of a street, etc., or whether they are in perspective and represent both sides thereof, the distinctive feature being the adaptation to stereoscopes of one or more symmetrical, independent, movable, endless bands, on which are right- and left-handed halves or corresponding parts of a stereoscopic panorama or succession of pictures. The top of this stereoscope consists, as usual, of two lenses, and the bottom is mounted on a box containing rollers on which are wound the endless bands, on which are printed, pasted, or otherwise appropriately attached, the views or pictures in panoramic succession, and also a train of wheel-work for setting the bands in motion. The bands, and corresponding parts of the pictures thereon, are brought under their respective lenses upon a flat stage or platform, over which the bands pass, so that when set in motion a panoramic stereoscopic view is obtained.

Compound Substances. Several substances united or mixed in one mass or solution.

Compressed Gas. The oxygen and hydrogen gases used for optical projection were formerly contained in large India-rubber bags, regulated by weights. These gases are now obtainable in a compressed form, contained in iron or steel cylinders, control being secured by the use of a pressure gauge placed at the orifice.

Concave. Curved inward; hollow; opposed to convex.

Concave Lens. A *plano-concave lens* is bounded by a plane surface on one side and a concave on the other. A *double-concave lens* has both sides concave. (See *Lens.*)

Concavo-Convex Lens. Is bounded by a

concave surface on one side and a convex surface on the other.

Concentrated. A liquid solution possessing more than the usual strength is said to be concentrated. (See *Solutions*.)

Concentration. The volatilization of parts of a liquid in order to increase the strength of the remainder. The operation can be only performed on solutions of substances of greater fixity than the menstruum in which they are dissolved. Many of the liquid acids, solutions of alkalies, etc., are concentrated by distilling off their water.

Concentric Lens. A symmetrical, wide-angle doublet, introduced by Ross & Co. in 1892, intended for landscape, architectural, and reproductive work. The construction of the "Concentric," shown in the cut given, was rendered possible by the new Jena glasses recently introduced by Abbe & Schott. The uncemented surfaces of each combination are concentric, the cemented surfaces being flat. The "Concentric" lenses are made from 3 inches to 18 inches focal length; are absolutely free from astigmation, distortion, and flare; give uniformly perfect definition with an equal illumination over a flat field of a circle of 75°, the oblique rays coming to focus with the same sharpness as the central pencils. The lens defines perfectly with its full aperture, the diaphragms being used only to regulate exposure and depth of focus. For reproductive work, *f.* 22 is recommended, while soft, diffused definition is obtainable with *f.* 16.

Fig. 47.

Condenser. A thick, convex lens, usually two plano-convex lenses, with flat sides outward in metal frame, used to illuminate a transparency while being copied, or for lantern projections.

Conjugate Foci. When rays of light are not parallel but diverge from a point, that point is associated with the focus, and the two are termed "conjugate foci." Therefore, although the principal focus of a lens (as determined by the degree of convexity) is always the same, yet the focus for objects near at hand varies, being longer as they are brought closer to the lens. This relative change in the focal length, due to any change in the distance of an object from the lens, is frequently brought under the notice of the photographer. Objects situated at various distances are necessarily brought to a focus at different distances from the lens, and the terms "little depth of focus" or "focussing only in one plane" are used in describing the effects produced. It is a consequence arising regularly from the very nature of the law of refraction; and neither the lens-maker nor the user can in any way alter whatever value it assumes for a particular case. In practice, as is well known, the photographer meets the case by using a sufficiently small stop, though in reality the distance between the conjugate foci remains as before. The following table will serve to facilitate the calculation of the conjugate foci, and affords a fair view of the conjugate focus for various distances. The principal focus of the lens is taken at 10 inches, and the nearest distance for the object at 50 inches; the successive distances increase by 5 until 160 inches, then by 10 inches until 260 inches, and after that by intervals chosen in such a manner as will give a tolerably orderly succession of conjugate foci.

Table.—Principal Focus 10 Inches.

Distance of object.	Conjugate focus.
50 in.	12.500 in.
55 "	12.222 "
60 "	12.000 "
65 "	11.818 "
70 "	11.667 "
75 "	11.538 "
80 "	11.429 "
85 "	11.333 "
90 "	11.250 "
95 "	11.176 "
100 "	11.111 "
105 "	11.053 "
110 "	11.000 "
115 "	10.952 "
120 "	10.909 "
125 "	10.870 "
130 "	10.833 "
135 "	10.800 "
140 "	10.769 "
145 "	10.741 "
150 "	10.711 "
155 "	10.690 "
160 "	10.667 "
170 "	10.625 "
180 "	10.588 "
190 "	10.556 "
200 "	10.526 "
210 "	10.500 "
220 "	10.476 "
230 "	10.455 "
240 "	10.435 "

Distance of object.	Conjugate focus.
250 in.	10.417 in.
260 "	10.400 "
300 "	10.345 "
410 "	10.250 "
510 "	10.200 "
670 "	10.152 "
1010 "	10.100 "
1121 "	10.090 "
1260 "	10.080 "
1430 "	10.070 "
1677 "	10.060 "
2010 "	10.050 "
2510 "	10.040 "
3340 "	10.030 "
5010 "	10.020 "
10000 "	10.010 "
Indefinite	10.000 "

A few examples will illustrate the use of the table.

Example 1. With a lens 10 inches focus and the distance 50 inches and another 55 inches, it is required to show the difference in the focal adjustment of these two objects.

Opposite 50 in. distance is	12.500 in.
Opposite 55 " " "	12.222 "
Ans.	0.278 "

Example 2.

Opposite 60 in. distance is	12.000 in.
Opposite 100 " " "	11.111 "
Ans.	0.889 "

Example 3. With a lens 10 inches focus and the distance of an object 1260 inches (or 105 feet), what is the increase of the conjugate focus over the focus for parallel rays?

Opposite 1260 in. distance is	10.080 in.
Focus for parallel rays	10.000 "
Ans.	0.080 "

Example 4. With a telescope whose focal length for a star is 60 inches; required, its focal distance for an object 60,000 inches or 5000 feet distance. In this case, as the principal focus is 6 times the tabular one of 10 inches, divide the distance by 6 and we get 10,000 inches.

Opposite 10,000 in. distance is	10.010 in.
	6 "
Ans.	60.060 "

We here multiply by 6 because we previously divided by 6 to get the tabular distance.

Example 5. There are two object-glasses, the one 10 inches focus and the other 20 inches focus; required, the conjugate focus of each lens for an object 210 inches distant, and its excess above the sidereal.

Opposite 210 in. is	10.500 in.	conjugate focus.
Sidereal focus 1st lens	10.000 "	
Ans., excess	.500 "	

For the second lens divide 210 by 2 and

Opposite 105 in. is	11.053 in.	
	2 "	
Ans.	22.106 "	conjugate focus.
Sidereal focus 2d lens	20.000 "	
Excess over sidereal	2.106 "	

Observe that the excess of the conjugate focus over the sidereal, in the case of the 20-inch lens, is rather more thon four times the similar quantity for the 10-inch focus lens.

Example 6. There are two object-glasses, the one 10 inches focus and the other 30 inches focus; required, the conjugate focus of each lens for an object 210 inches, and its excess above the sidereal focus.

Opposite 210 in. is	10.500 in.	conjugate focus.
Sidereal focus 1st lens	10.000 "	
Ans., excess	.500 "	

For the second lens divide 210 by 3, because 30 inches focus is three times the tabular standard focus.

Opposite 70 in. is	11.667 in.	
	3 "	
	35.001 "	conjugate focus.
Sidereal focus 2d lens	30.000 "	
Excess	5.001 "	

The real excess is 5.000 (the fraction .667 being merely the aberration of the continued fraction .666, etc.), and is ten times the similar quantity for the first lens.—*Goddard.* (See also *Law of Conjugate Foci.*)

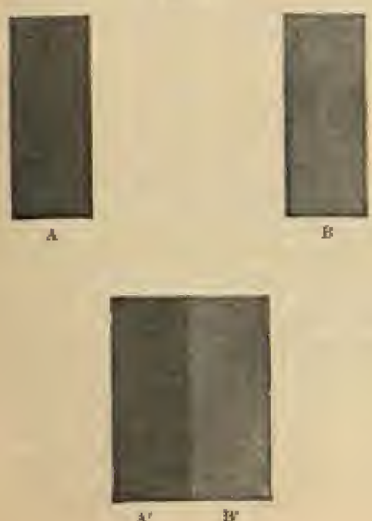
Contact, Optical. The mechanical connection of two bodies so close that, seemingly, they have but two instead of four planes; for instance, a looking-glass in which glass and amalgam are in perfect optical contact.

Contact Printing. Printing by contact; making a positive from a negative in a printing frame, either by printing out, or partial printing with subsequent development.

Continuating Glasses. In photography, a term applied to glasses tinged with red or yellow color, and which, by some inherent

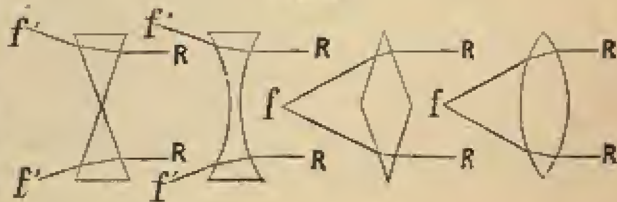
principle, possess the power of continuing the darkening of the photograph after it has been removed from the camera and placed under them. They are founded upon the principle that certain rays exist which are capable of exercising primitively an action upon the prepared paper, or plate, whilst their rays are well calculated to continue that action when it has been begun by other rays. This important discovery was made by Mr. E. Becquerel, who gives the following directions for the use of the glasses: The plate is *iodized* and exposed in the camera about fifteen times longer than when operating with bromine-water. On taking it out, carefully preserving it from the least ray of light, it is put into a sheath covered with yellow glass, and exposed to direct solar radiations. The time for this exposition cannot be determined precisely; but the operation presents no difficulty, for the operator can see the progress of the action through the yellow glass. The proof is, therefore, only withdrawn when the image has attained the required intensity and tone. By this process, views may be obtained of exquisite delicacy of detail, and of a very peculiar tone.

FIG. 48.



Contrast. The correlation of the different parts of a figure or of different figures (in groups), and proper vigor of light and shade. The term is used by photographers to define the similarity or dissimilarity in shade of the different portions of a picture. In Fig. 48, the two surfaces A and A′ are shaded precisely alike; the same is true of B and B′. But while it is difficult to determine the difference in brightness between A and B, the difference between A′ and B′ is quite marked. At the same time another peculiarity will be noticed. Each of the two surfaces touching each other looks as if it were shaded off toward one side, while in reality each is covered with a perfectly even tint. Furthermore, the brighter surface

FIG. 49.



appears to increase in brightness, the darker one in darkness, toward the boundary line. It follows that the effect of contrast is strongest at this line.

Contretype. A gelatine plate, made sensitive to light with bichromate of potassium, is exposed under a negative, and afterward immersed in water colored with Indian ink or other pigment. Those portions not acted upon by light absorb the colored liquid, and after fixation a negative is the result.

Convergence. The quality of converging.

Converging. Tending to one point. Rays of light which, proceeding from different points of an object, tend toward a single point, converge; at this point they cross and become diverging rays.

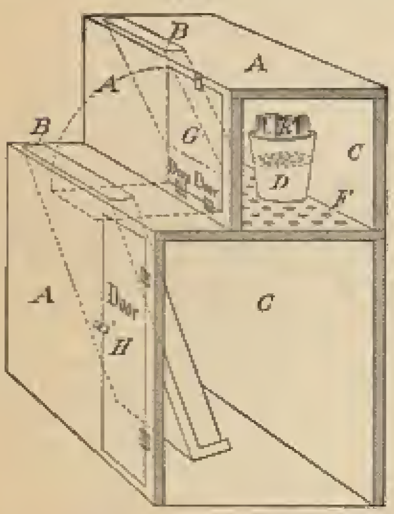
Converging Lens. The converging lens may be considered as prisms united at their bases, and a diverging lens as prisms united at their apices. As we already know that prisms refract parallel rays toward the base, it is easily seen why converging lenses refract the rays *R R* (Fig. 49) to *f*, and that diverging lenses diverge the rays *R R* to *f′*. The distance of the focus from the lens depends, first, upon the curvature; second, upon the

refracting power of the material of the lens; and third, upon its thickness.

Convex Lens. There are two kinds of convex lenses. The *plano-convex lens* is bounded by a plane surface on one side, and by a convex on the other. A *double-convex lens* is bounded by two convex-spherical surfaces.

Cooling Box. A, the box; B B, baths; C C, upper and lower chambers; D, a pail in two sections; E, ice; F, perforated bottom of upper chamber; G, door to upper section which, for convenience, should be hinged at the bottom, so as to drop forward. H, the

FIG. 50.



door to the lower section. If heat is required; as in winter, a gas-jet may burn in the lower section.

Copal. A resinous substance which exudes spontaneously from the Rhus copallinum, and the Elaeocarpus copalliferus. When of good quality it is too hard to be scratched by the nail, and has a conchoidal fracture. It dissolves with difficulty, and this, combined with its extreme hardness, renders it very valuable for making varnishes. The solvents of copal are: *Caoutchoucine* (a highly volatile fluid—discovered by Mr. Barnard—having the property, if mixed with alcohol, of dissolving all the resins, and mixing with the oils in all proportions), sparingly. Equal parts of *caoutchoucine* and *alcohol* of 0.825; freely soluble in the cold. *Absolute alcohol*, added gradually to the copal, previously rendered gelatinous by water of ammonia, assisting the union with heat. *Alcohol* added to the copal previously softened by ether. *Alcohol* to which a little camphor has been added. *Ether*, afterward diluted with alcohol. *Oils of rosemary and lavender*. *Turpentine*, after heating the copal until it fuses. *Drying linseed oil*, at nearly the boiling-point; afterward diluting with alcohol and turpentine. In all the above cases the copal should be reduced to a *coarse* powder; a *fine* powder is apt to stick together and form hard lumps. The solution of copal, even in its most ready solvents, is attended with some difficulty, and frequently miscarries in the hands of the inexperienced.

Copper Etching Process. Although long used as the basis for photogravure (intaglio) engraving, copper has only recently been applied in the production of relief printing blocks for line or half-tone work. In these latter processes a copper plate is buffed or polished, coated with a film composed of fish glue, albumen, and bichromate of ammonium, which, when dry, is exposed under a negative in the usual way. When printed the plate is soaked (or developed) in cold water, dried with alcohol, and "burnt in" by placing upon an iron plate over a gas-stove, until the film appears a rich brown color. It is then allowed to cool gradually, and etched with perchloride of iron in diluted solution, with repeated etchings until the desirable depth is acquired. After washing and drying, the plate may be mounted as usual for the press.

Copying. The process of reproducing paintings, engravings, daguerrotypes, or other works of the fine arts. The manipulations are the same as for any other photograph; but as some directions in other points may be useful they will be given under appropriate heads.

To copy a photograph or picture the print should be mounted smoothly on a flat surface; unmounted prints may be copied by being attached to a board under a piece of flatted plate glass. The print is squared with the camera, and must be absolutely perpendicular. The best plan is to attach a piece of board at right angles with a longer board or table upon which the copying camera is fixed, so as to run along

grooves; this board is so placed that an evenly diffused light reaches the picture to be copied. Focussing should be done carefully, and sharp definition secured; a good rectilinear wide-angle lens is adapted for this work. A "slow" plate is desirable, and the exposure must be carefully timed to get a brilliant reproduction. The developer should be carefully restrained, and of such composition that density may be readily secured without the addition of much alkali.

Copying Camera. A camera used for the reproduction of photographs, engravings, paintings, charts, etc. It can be very much extended; that is, the shield and lens may be moved apart very much. It must stand level and must be protected from jar.

Copying Crystallizations. Dr. Vogel suggests that crystallizations may be formed on glass surfaces by means of cold or electricity, or even by the influence of sound, and printed photographically the same as from any other negative.

Copying Daguerrotypes. The chief difficulty in making copies of daguerrotypes is that they are produced in a much lower tone than the original—in fact, this remark will apply to copies of all kinds of photographs. The freshness and brilliancy of fine daguerrotypes can never be imparted to the copy, but they can be reproduced as clear, distinct, and strong as the originals; more than this should not be expected. In making copies use a quarter-size camera capable of sufficient extension to copy the required size. The aperture should be diaphragmed down to a half-inch. The picture to be copied must be placed in the direct rays of the sun, "upside down," its centre directly opposite the centre of the lens. The manipulations are the same as for making an original daguerrotype. By having the camera box sufficiently large the smallest daguerrotype can be enlarged to any size.

Copying Engravings or Drawings. This is one of the most difficult processes in photography to execute well. Provide yourself with a stand for the camera which may be elongated at pleasure, and having at one end an upright frame on which to place or stretch the picture to be copied. The engraving must be placed in the sunlight to insure clearness and strength, its centre on a line with the centre of the lens. In making negatives on glass by the collodion process the same rules must be observed as for the ordinary—the obstacles to success being in the nature of the engraving or drawing; of the light, and in the action of the chemicals. The collodion must be more dense, stronger sensitized, and older, than for negatives from life; new collodion seldom gives good results. The nitrate bath should contain at least 40 grains of silver salt to the ounce of water; the developer as given for the collodion negative process. It is better to underexpose in the camera, and to bring up the strength of the negative by re-development, or by intensifying with bichloride of mercury, etc. (See *Intensifying* and *Density*.) If the bichloride of mercury is used, the exposure should be very little more than for an ambrotype. The usual time with old collodion is from two to four minutes with an orthoscopic lens.

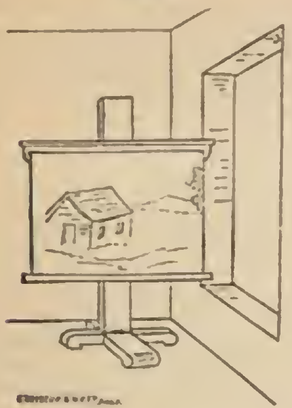
Copying Glass Positives. The rules for this process are the same as for the daguerrotype, and the chemical manipulations the same as for the ordinary collodion positive or negative processes, according to the nature of the copy you wish to produce.

Copying Oil Paintings. This is even more difficult than copying engravings, particularly where much yellow and red have been used in the original. Mr. Bulty, an English photographer, gives the following method as having proved the most satisfactory in his experience. Expose the plate to photographic action, collodion side reversed from the general practice; that is, so that the rays of light pass through the glass plate to get to the collodion; then finish in the usual way. Cramer's isochromatic plates, without color-screen are employed for this purpose. The plan of Mr. W. L. Shoemaker he describes as follows:

"I soon found that lighting from more than one point produced reflections that were avoided if the light came direct from one point only; and also, the stronger the light, the finer the reproduction. Also, that any light falling on the floor or objects in front of the picture gave counter-reflections; this can be easily avoided by covering with light cloths, or by avoiding such a location. The simplest plan was a success—anyone trying it will succeed, without doubt, in copying a painting so that it will be strong, crisp, and without any reflections: Place the picture in a perpendicular position in the sun, at a side window, placing it near the dark edge of the window, and in almost a

direct line with the light. (See drawing.) A little diluted glycerine assists to clear the

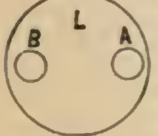
Fig. 51.



shadows for copying, but I would advise against the use of oil, as it will not dry quickly enough before delivery."

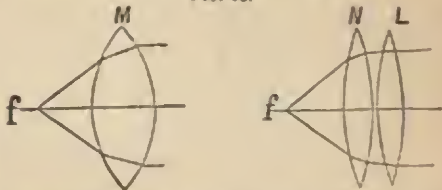
Correction of Large Lenses. It is frequently asked why a large photographic objective does not give the same sharp image that a small one does. It is somewhat more difficult to correct a large objective than a small one, even if the aperture stands in the same relation to the focal length. But it is not only this. Suppose we have a large photographic objective, say of six inches aperture, L (Fig. 52). Each part of the lens receives radiating rays from each point of the object, and brings them to a focus at the respective place. If we cover the lens by pasting paper over it, leaving only the aperture A free, we still get an image, only more feeble in light. Again, cover the aperture A, and open the aperture B, you get an image of the same object; but the apertures A and B are, say, four inches apart. Both cannot give precisely the same image, as they are taken from another base. The images will be similar to the two images of a stereograph, which are taken in a similar way by two lenses. Now open both apertures, A and B, and, as the images are not equal, they cannot cover each other, but will overlap, especially the images of the nearer objects. If we now use the whole aperture of six inches diameter, it is clear that we will have an infinite number of images none equal to the other, every one overlapping the other, and the image necessarily must be a blurred one. For this there is no remedy but cutting down the aperture.

Fig. 52.



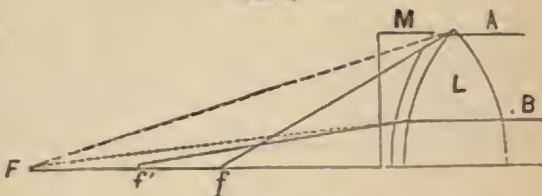
Correction of Spherical Aberration. This may be done by a second lens of opposite character. The larger the focus, the less the aberration. (See Fig. 53.)

Fig. 53.



Suppose we want to correct the spherical aberration of the positive lens L (Fig. 54) along its axis. f f′ is the longitudinal spherical aberration of the rays A B, parallel to the axis, A at the margin of the lens, and B near the centre of the lens L. If we combine this lens with a convergent negative lens M, it is not difficult to see, by what we learned before (see under *Aberration* and *Coincidence*), that the lens M has very little power to change the direction of the ray B f′, and bring it, say, to F; but it will greatly change the course of A f, so as to bring it also to F, since the prismatic form is greater at the margin than at the centre.

Fig. 54.

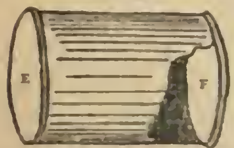


Of course, the form of the lens must be suited to the material of which it is made; for our present purpose, both of the lenses

may be made of the same glass, but it is much better if the lens M is made of a denser glass than L is made of, so that the same lens may be used to correct the chromatic aberration also. By this method the spherical aberration can not only be corrected, but the marginal rays can be made to cross the axis farther from the lens than the central ones; in this case the lens is called over-corrected.

Corrector for Negatives. For this purpose, a tube presenting the appearance of an ordinary objective is made, but instead of lenses, it has (as shown) two metallic disks, E and F, pierced with a narrow slit. These disks are mounted at the extremity of the tube by means of two rings and may easily be replaced by others having wider or narrower slits and varied as regards shape. For example, instead of a straight line on one of the disks, we may have a curved or broken line. The disks, being loosely fixed in the rings, may be made to turn and thus change the respective position of the slits. In this way it is possible to correct, and even to beautify a negative, by correcting its lines in one direction or another, as the operator may desire. It is possible, for example, to diminish the exaggeration of a face by reproducing it in this way. The greatest exactness is necessary in cutting the slits.

FIG. 56.



Corrosive Sublimate. (See *Bichloride of Mercury.*)

Countertype. A negative obtained from another one, by first making a positive, and from this another negative, by contact or in the camera. The resulting negative is softer than the original, and for that reason this mode is sometimes substituted for reducing a too intense negative.

Cowan's Taupenot (Rapid) Process. Introduced by the Rev. J. Galloway Cowan. Obsolete.

Cowper's Apparatus for Photographing on Uneven Surfaces. In the ordinary photographic apparatus or camera the object or picture is focussed on a plate of ground-glass, which is then withdrawn and replaced by a slide or frame containing the prepared or sensitive plate or surface which is to receive the impression. This mode of proceeding is not applicable when the impression is to be taken on the side of a vase or other uneven surface. By Mr. Cowper's invention the vase or uneven surface is placed in the camera and the picture is focussed upon it, and it is then removed and covered with a coating of collodion or other suitable material and rendered sensitive to light, and then replaced in the camera in the same position as when the picture was focussed: it is then exposed a sufficient time and is developed and fixed in the usual manner. In order to replace it in the same position that it had previously occupied, the following apparatus is employed: A piece of wood or other suitable material is fitted in a guide or grooves at the bottom of the camera, so as to be capable of sliding backward and forward, and secured by a screw or nut. This board carries a cylindrical upright rod on which slides a cylindrical socket carrying a frame, in which is fitted a pan of rectangular or other suitable form. This frame also carries another vertical rod with a screw socket and an elbow arm which carries a thin metallic frame of the size of the intended picture. In the pan is a quantity of clay, putty, or other plastic material or cement, in which the foot of the vase or other article is imbedded or placed in such a manner that it can be removed and replaced again exactly as before. It is placed so that the part which is to receive the picture may be as nearly vertical as possible, and its position is adjusted by the slides and means before mentioned until the picture is found to be properly in focus. The thin frame is also adjusted to the vase, which is then removed and rendered sensitive and again replaced, and the picture taken in the usual manner. The coating may be applied in some cases before focussing. The object to be copied may be a landscape or a natural object, a painting, a photograph, or any other object. Mr. Pyne, of New York, has also patented a similar apparatus for this purpose.

Crayon Daguerrotype. The invention of J. A. Whipple. In taking these pictures a white background is used, placed six or seven feet from the sitter. The plate is coated as usual, and the focus of the image is placed near the centre of the plate. While the plate is exposed, a black cloth or piece of stout paper stretched upon a hoop, having

one-half of the circle open and the inner edge of the cloth cut in the form of a crescent, is kept in motion between the camera and sitter in such a way as to cut off the entire bust.

Creosote. An oily liquid obtained from wood and peat, colorless after double purification, preventing decomposition.

Cristallos. Name of a rapid hydroquinone developer introduced by a French firm. Its formula is: (*a*) Hydroquinone 10, sulphite of soda 40, yellow ferrocyanide of potassium 120, water 900; (*b*) caustic soda 50, water 100. For use, 60 parts of *a*, 6 parts of *b*, and a few drops of bromide of potash (1 : 10).

Crown Glass. Optical glass, free of lead, composed of fossil meal, potash, and calcium. The biconvex lenses of both single and double combinations are crown glass.

Crucible. A vessel of burned clay or porcelain, used to hold dry substances which are to be subjected to a high temperature.

Crystallization. The act or process by which the parts of a solid body, separated by the intervention of a fluid, or by fusion, again coalesce or unite and form a solid body. If the process is slow and undisturbed, the particles assume a regular arrangement, each substance taking a definite and regular form, according to its natural crystallization; but if the process is rapid or disturbed, the substance takes an irregular form. This process is the effect of refrigeration or evaporation.

Crystal Medium. Mica applied to photography. The process consists in using mica instead of glass to cover the *carte-de-visite* portraits. Being perfectly flexible it can be applied to these portraits, which are put up in flexible pocket-cases, without the danger of breakage which would, of course, attend the use of glass.

Crystalotype. An obsolete photographic process, invented and patented by J. A. Whipple. It is supposed to be the first attempt to make negatives on glass covered with a film of albumen. (See *Albumen Process*.)

Crystoleum. Syn., Chromo-photographs. A photograph attached to the hollow side of a curved glass, rendered transparent, and colored from the back of the print with oil colors.

Cupro-Ammonium. A salt formed by treating copper in aqua ammonia.

Cupro-Ammonium Process. This process was the discovery of M. Van Monkhoven. Instead of collodion an iodized solution of cotton in oxides of cupro-ammonium is used. The method is thus described by the inventor: You begin with the oxide of copper. In 50 ounces of lukewarm water dissolve 54 ounces of common sulphate of copper. In another vessel dissolve 36 ounces caustic potash in its own weight of water and mix the solutions; stir it with a glass rod and a precipitate falls. Draw off the clear liquid with a siphon and wash the precipitate with fresh water. It is then left for some hours and the clear liquid again drawn off. Repeat three times to obtain the salt perfectly pure. Lastly the precipitate is thrown upon a cloth spread out in the air. The excess of water filters through and in 24 hours the mass acquires the consistency of paste. Put this into a flask with a wide mouth, and add to it 360 ounces of commercial liquid ammonia, which should be perfectly colorless. The whole of the oxide of copper dissolves on shaking the flask and you obtain a liquid of a magnificent deep-blue color. Let it rest 24 hours and then decant, say 36 ounces, and add to it 1550 grains well-carded cotton. Agitate until the whole of the cotton is dissolved; then dilute it with 9 ounces of water. This is the liquid which is to serve for the ulterior operation. It is very important to have a liquid properly prepared. In order to try it pour a little upon a glass; it should spread itself slowly and uniformly. You will fail if the liquid is too thin. When you wish to convert the cupro-ammoniacal liquid into a photographic compound add to it from 1 to 2 per cent. of iodide of potassium dissolved in twice its weight of water.

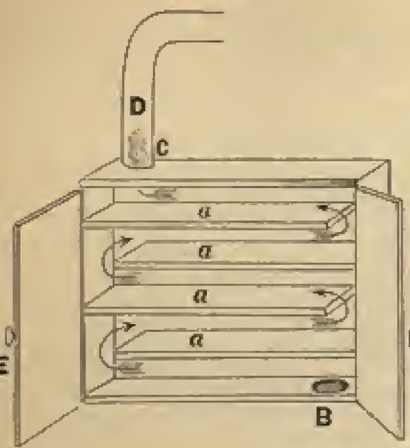
When you wish to use it pour a certain quantity of it upon a glass in the same way as collodion; place it upright against the wall; let the excess of liquid run off, removing it at the same time with a piece of blotting-paper, and then immerse it, quite wet, in the following bath:

Distilled Water	1000 parts.
Fused Nitrate of Silver	100 "
Glacial Acetic Acid	50 "

In this bath it becomes white immediately. After immersion for a few seconds remove it, and continue the operations as in the ordinary collodion process.

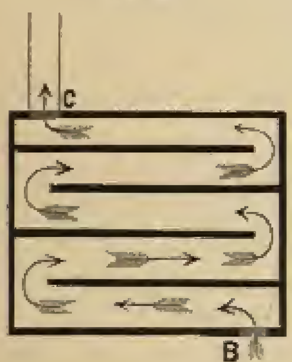
Cupboard for Drying Lantern Slides. The apparatus is made of zinc, varnished. *a, a, a, a*, plate-glass shelves reaching across cupboard within 1½ inches of the opposite

FIG. 56.



side, as shown in the figure. B, a hole over which is soldered a piece of fine wire gauze. This is the air inlet. It should be covered with fine linen to stop dust and dirt

FIG. 57.



from entering. The linen should be dipped into glycerine and changed occasionally. Another outlet at C is connected with a sheet-iron piping, D. A Bunsen burner is placed at D. The doors E E are closed after the prepared plates have been laid upon the shelves. The lighting of the burner establishes a draught of air in the direction of the arrows, which dries the plates quickly.

Cupric Bromide. Prepared by mixing a solution of 1 part of potassium bromide in 25 parts of water, with a solution of cupric sulphate in 25 parts of water; allow to settle and filter off the clear liquid. Suggested by Bottone, in 1891, as an intensifier giving increased contrast in the negative. The method employed is as follows: Wash the negative free from hypo, and immerse it in the solution of cupric bromide, which converts it into a brilliant white positive. Wash well and immerse in diluted ammoniacal liquid (liq. ammon. 0.880, diluted with 12 parts of water).

This intensifier is adapted for wet collodion negatives in photo-mechanical work. In this case the bleached image is treated with a solution of silver nitrate instead of ammonia.

Liesegang, after an exhaustive investigation of the salts of copper, has prepared a sensitive cupric bromide paper which gives a developable image after three-fourths of an hour's exposure to sunlight.

Cupric Sulphate. Syn., Sulphate of copper, bluestone, blue vitriol, blue copperas. Prepared by roasting copper pyrites at a high temperature, with free access of air, the ferrous sulphate formed being decomposed, and cupric sulphate remaining unchanged. Soluble in twice its weight of cold water. Used for the intensification of negatives in reproduction work in the subjoined formula: (1) Bromide of potassium ¼ ounce, water 4 ounces; (2) cupric sulphate ½ ounce, water 4 ounces. Immerse the negative in a mixture of equal parts 1 and 2 until bleached, and then blacken with nitrate of silver solution (30 grains to the ounce).

Curtains. The diagram (Fig. 58) shows the arrangement of curtains as used in the ordinary skylight. They should be so mounted by means of springs and rollers as to be quickly changeable, and made to fly rapidly where wanted, by means of framework similar to that shown.

Curtain Shutter. A sky-shade shutter. An instantaneous shutter, consisting of two wings, each of which, by pneumatic pressure, describes half a circle, the upper one opening the objective, the lower immedi-

ately closing it again. The motion of the lower wing may be accelerated, giving the sky a shorter exposure than the foreground.

FIG. 58.

Curcuma (Turmeric). Brilliant yellow prisms from the substance of curcuma root. Paper saturated with solution of curcuma turns brown in alkalies and black to yellow in acids.

Curvature of Field. The image of a flat object, formed by a lens, cannot be received on a plane screen; the screen ought to be concave. A, B and, C (Fig. 59) are very

FIG. 59.

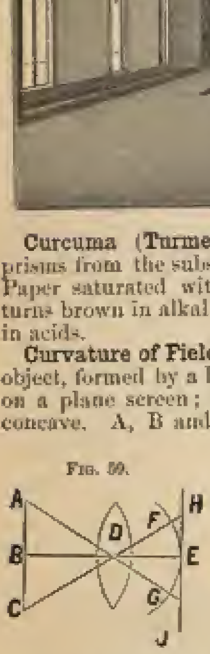
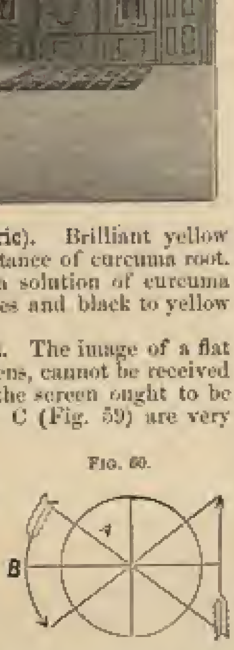


FIG. 60.



distant points (and, therefore, nearly equally distant from the lens D), of which the point B is situated in the line of the axis of the lens, while the points A and C are above and below the axis. It is evident that the images of these points are formed at nearly equal distances from the optical centre, not far from the principal focus. The field F E G is therefore curved, and cannot be received on the screen H J equally sharp. The curvature of field is generally attributed to spherical aberration; sometimes it is even thought to be spherical aberration itself, but it has nothing to do with it. If lenses could be made with parabolic curves, free from spherical aberration, the curvature of field would be about the same.

Suppose we have a globular lens, A (Fig. 60), with a diaphragm in the middle, so small as to reduce spherical aberration to almost nothing. Now we know that the focus of a sphere of crown glass is situated one-quarter of the diameter behind the globe, at B, and as all the pencils are normal, they all will form their image one-quarter of the diameter of the globe behind it; that is, the image lies in a curve, concentric with the lens, although the spherical aberration is not perceptible.

To understand the correction of the curvature of field, we must be clear as to what is meant by depth of focus, and what the effect of a diaphragm is.

Cut-off Jet. An ingenious appliance of the optical projection lantern, by which the light of the lantern may be turned down during an interval without disturbing the adjustment of the ordinary blow-through or other jet used.

Cuvette. In photography, a narrow vertical vessel of glass, porcelain, gutta-percha, or vulcanite, used to contain the nitrate of silver solution for the collodion process, the cyanide, developer, etc.

Cyanate. A compound formed by the union of cyanic acid with a base. Cyanates are distinguished by evolving the odor of cyanic acid, accompanied by effervescence, when treated with dilute mineral acids, and by this solution, mixed with hydrate of lime. The alkaline cyanates are soluble, the others insoluble.

Cyanate of Ammonia. This salt is formed by mixing dry ammoniacal gas with the vapors of hydrated cyanic acid, which deposits a white, woolly, semi-crystalline mass. By heat or exposure to the air, it is converted into urea. Solutions of this salt may be used for fixing.

Cyanate of Potassa. May be formed by roasting, at a red heat, dry ferrocyanide of potassium, in fine powder, upon an iron plate, constantly stirring until it becomes fused into one mass, when it must be reduced to fine powder and digested in boiling alcohol, from which crystals of the cyanate will be deposited as the solution cools.

Cyanate of Silver and of other metallic substances may be made by adding a solution of cyanate of potassa to another of a neutral salt of the base.

Cyanide. A compound of cyanogen and a metal. (See *Cyanogen*.)

Cyanide of Iodine. A union of cyanogen and iodine, produced by mixing together 2 parts bi-cyanide of mercury and 1 part dry iodine, by means of trituration on porphyry; this mixture is then put into a retort with a large neck and bent tube, connecting with a flask. A gentle heat is applied to the retort, when woolly-like crystals of cyanide of iodine are distilled over. These should be put into a bottle with a ground stopper. This salt can be used advantageously for the first preparation of negative paper. The solution should be made as follows:

Cyanide of Iodine	1 grain.
Alcohol	12 ounces.
Iodide of Potassium	2 grains.

The paper should be floated on this for some minutes, and then dried and put away for use. When required for the proof, it must be submitted to the aceto-nitrate of silver bath and dried with blotting-paper. After exposition it is fixed in the usual way.

Cyanide of Potassium. A union of cyanogen with potassium. Cyanide of potassium dissolves the iodide, chloride, and bromide of silver, as well as almost all the other salts of this metal, when it is added in excess. It also dissolves the protoxides and suboxides of this metal (of a black color) precipitated by gallic acid. It is also excellent, in solution, for removing—with the aid of a sable pencil—the black spots which so often spoil a good proof. The operator, however, should be careful to arrest its action at the proper moment, as if left too long it will remove too much. To do this one must quickly wash the proof in clear water acidulated with hydrocyanic acid, and again wash it in several waters. Cyanide of potassium is extensively employed in photography for fixing ambrotypes and negative collodion proofs; for the formation of solutions for the preparation of paper (see the various processes); and for preparing the silvering solution for galvanizing purposes (see *Galvanizing*). It is also used for removing stains of nitrate of silver from the hands, in the proportion of 1 grain of the salt to 10 grains of water—but as it is a very active poison, great care should be taken, particularly if the hands are gashed or chapped.

Cyanide of Silver. A compound of cyanogen and silver. Add hydrocyanic acid to a solution of nitrate of silver as long as a precipitate is deposited; wash and dry. This salt is white, soluble in ammonia, and decomposed by contact with neutral vegetable substances. By exposure to light it becomes violet-colored. By decomposition, chloride of silver is formed. Cyanide of silver is very sensitive to light, but is still more so when the fluoride of potassium is added. In photography it is used for galvanizing purposes.

Cyanine Iodide. Syn., Cyanine, quinolin, or chinolin blue, quinolin-cyanine. Sold as a dark blue-green powder with metallic lustre, partly soluble in water, more so in alcohol. Used as a sensitizer in orthochromatic work, making gelatine bromide plates more sensitive to red rays. It is extremely sensitive to light, and should be kept in the dark. A weak solution is bleached by exposure to light. (See *Chloro-cyanine*.)

Cyanogen. A colorless gas composed of carbon and nitrogen, and possessing a pungent and peculiar odor. It is prepared by exposing carefully dried bi-cyanide of mercury in a small retort, to the heat of a spirit lamp, and collecting the gas in the mercurial pneumatic trough. Water absorbs nearly five times its bulk of cyanogen at 60°; alcohol about 23°. With hydrogen it forms hydrocyanic acid, and with the metals, cyanides or cyanurets.

Cyanogen Soap. A compound used for the removal of silver stains from the hands or linen.

Cyanotype. The process in which cyanogen is employed; discovered by Sir John Herschel. Paper simply washed with a solution of ferro-sesquicyanuret of potassa is highly sensitive to the action of light. Prussian blue is deposited. After half an hour or an hour's exposure to sunshine, a very beautiful negative photograph is the result, to fix which, all that is necessary is to soak it in water in which a little sulphate of soda is dissolved, to insure the fixity of the Prussian blue deposited. While dry, the impression is dove-color or lavender blue, which has a striking effect on the greenish-yellow ground of the paper, produced by the saline solution. After washing, the ground-

color disappears, and the photograph becomes bright blue on a white ground. If too long exposed, it gets "over-sunned," and the tint has a brownish or yellowish tendency, which, however, is removed in fixing; but no increase of intensity beyond a certain point is obtained by continuance of exposure. If paper be washed with a solution of ammonio-citrate of iron, and dried, and then a wash passed over it of the yellow ferrocyanuret of potassium, there is no immediate formation of true Prussian blue, but the paper rapidly acquires a violet-purple color, which deepens after a few minutes, as it dries, to almost absolute blackness. In this state it is a positive photographic paper of high sensitiveness, and gives pictures of great depth and sharpness, but with this peculiarity, that they darken again spontaneously on exposure to the air in darkness, and are soon obliterated. The paper, however, remains susceptible to light and capable of receiving other pictures, which in their turn fade without any possibility of arresting them, which is to be regretted, as they are very beautiful, and the paper of such easy preparation. If washed with ammonia or its carbonate, they are for a few moments entirely obliterated, *but presently reappear, with reversed lights and shades.* In this state they are fixed, and the ammonia, with all that it will dissolve, being removed by washing in water, their color becomes a pure Prussian blue, which deepens much by keeping. If the solution be mixed, there results a very dark violet-colored ink, which may be kept uninjured in an opaque bottle, and will readily furnish, by a single wash, at a moment's notice the positive paper in question which is most sensitive when wet. It seems at first sight natural to refer these curious and complex changes to the instability of the cyanic compounds; and that this opinion is to a certain extent correct, is proved by the photographic impressions obtained on papers to which no iron has been added beyond what exists in the ferrocyanic salts themselves. Nevertheless, the following experiments abundantly prove that in several of the changes above described, the *immediate action* of the solar rays is not exerted on these salts, but on the iron contained in the ferruginous solution added to them, which it deoxidizes or otherwise alters, thereby presenting it to the ferrocyanic salts in such a form as to precipitate the acids in combination with the peroxide or protoxide of iron, as the case may be.

To make this evident all that is necessary is *simply to leave out the ferrocyanate* in the preparation of the paper, which thus becomes reduced to a simple washing over with the ammonio-citric solution. Paper so washed is of a bright-yellow color, and is apparently little, but in reality is highly sensitive to photographic action. Exposed to strong sunshine for some time, indeed, its bright-yellow tint is dulled into an ochrey hue, or even to gray, but the change altogether amounts to a moderate percentage of the total light reflected, and in short exposures is such as would easily escape notice. Nevertheless, if a slip of this paper be held for only four or five seconds in the sun (the effect of which is quite imperceptible to the eye), and when withdrawn into the shade be washed over with the ferro-sesquicyanate of potash, a considerable deposit of Prussian blue takes place on the part sunned, and none whatever on the rest; so that on washing the whole with water, a pretty strong blue impression is left, demonstrating the reduction of iron in that portion of the paper to the state of protoxide. The effect in question is not, it should be observed, peculiar to the ammonio-nitrate of iron. The ammonio- and potasso-tartrate fully possess, and the perchloride *exactly neutralized* partakes of, the same property; but the experiment is far more neatly made and succeeds better with the other salts.

In further development of these most interesting processes Sir John Herschel says: "The varieties of cyanotype processes seem to be innumerable, but that which I shall now describe deserves particular notice, not only for its pre-eminent beauty while in progress, but as illustrating the peculiar power of the ammoniacal and other persalts of iron above mentioned to receive a latent picture susceptible to development by a great variety of stimuli. This process consists in simply passing over the ammonio-citrated paper on which such a latent picture has been impressed, *very sparingly and evenly,* a wash of the solution of the common yellow ferrocyanate (prussiate of potash.) The latent picture, if not so faint as to be quite invisible (and for this purpose it should not be so), is negative. As soon as the liquid is applied, which cannot be in too thin a film, the negative picture vanishes, and by very slow degrees is

replaced by a positive one of a violet-blue color on a greenish-yellow ground, which at a certain moment possesses a high degree of sharpness, and singular beauty and delicacy of tint. If at this instant it be thrown into water, it passes immediately into Prussian blue, losing at the same time, however, much of its sharpness, and sometimes indeed becoming quite blotty and confused. But if this be delayed, the picture after attaining a certain maximum of distinctness, grows rapidly confused, especially if the quantity of liquid applied be more than the paper can easily and completely absorb, or if the brush in applying it be allowed to rest on, or be passed twice over, any part. The effect then becomes that of a coarse and ill-printed woodcut, all the strong shades being run together, and a total absence prevailing of half-lights. To prevent this confusion, gum arabic may be added to the prussiated solution, by which it is hindered from spreading unmanageably within the pores of the paper, and the precipitated Prussian blue allowed time to agglomerate and fix itself on the fibres. By the use of this ingredient also, a much thinner and more equable film may be spread over the surface; and *when perfectly dry*, if not sufficiently developed, the application may be repeated. By operating thus I have occasionally (though rarely) succeeded in producing pictures of great beauty and richness of effect, which they retain (if not thrown into water) between the leaves of a portfolio, and have even a certain degree of fixity—fading in a strong light and recovering their tone in the dark. The manipulations of this process are, however, delicate, and complete success is comparatively rare. If sulphocyanate of potash be added to the ammonio-citrate, or ammonio-tartrate of iron, the peculiar red color which that test induces on persalts of the metal is not produced, but it appears at once on adding a drop or two of dilute sulphuric or nitric acid. This circumstance, joined to the perfect neutrality of these salts, and their power, in such neutral solution, of enduring, undecomposed, a boiling heat, contrary to the usual habitudes of the peroxide of iron, together with their singular transformation by the action of light to proto-salts, in apparent opposition to a very strong affinity, has, I confess, inclined me to speculate on the possibility of their ferruginous base existing in them, not in the ordinary form of peroxide, but in one isomeric with it. The non-formation of the Prussian blue, when their solutions are mixed with prussiate of potash, and the formation in its place of a deep violet-colored liquid of singular instability under the action of light, seems to favor this idea. Nor is it altogether impossible that the peculiar 'prepared' state superficially assumed by iron under the influence of nitric acid, first noticed by Keir, and since made the subject of experiment by M. Schonbein and myself, may depend on a change superficially operated on the *iron itself* into a new metallic body isomeric with iron, unoxidable by nitric acid, and which may be considered as the radical of that peroxide which exists in the salts in question, and possibly also of an isomeric protoxide. A combination of the common protoxide with the isomeric peroxide, rather than with the same metal in a simply higher stage of oxidation, would afford a not unplausible notion of the chemical nature of that peculiar intermediate oxide to which the name of 'Ferroso-ferric' has been given by Berzelius. If (to render my meaning more clear) we for a moment consent to designate such an isomeric form of iron by the name siderium, the oxide in question might be regarded as a siderite of iron. Both phosphorus and arsenic (bodies remarkable for sesqui-combinations) admit isomeric forms in their oxides and acids. But to return from this digression. If to a mixture of ammonio-citrate of iron and sulphocyanate of potash a small dose of nitric acid be added, the resulting red liquid, spread on paper, spontaneously whitens in the dark. If more acid be added till the point is attained when the discoloration begins to relax, and the paper when dry retains a considerable degree of color, it is powerfully affected by light, and receives a positive picture with great rapidity, which appears at the back of the paper with even more distinctness than on its face. The impression, however, is pallid, fades on keeping, nor am I acquainted at present with any mode of fixing it. If paper be washed with a mixture of the solutions of ammonio-citrate of iron and ferro-sesquicyanate of potash, so as to contain the two salts in equal proportions, and being then impressed with a picture, be thrown into water and dried, a negative blue picture will be produced. This picture I have found to be susceptible of a very

curious transformation, preceded by total obliteration. To effect this it must be washed with solution of protonitrate of mercury, which in a little time entirely discharges it. The nitrate being thoroughly washed out and the picture dried, a smooth iron is to be passed over it, somewhat hotter than is used for ironing linen, but not sufficiently so to scorch or injure the paper. The obliterated picture immediately reappears, not blue, but brown. If kept for some weeks in this state between the leaves of a portfolio, in complete darkness, it fades, and at length almost entirely disappears. But what is very singular, a fresh application of the heat revives and restores it to its full intensity. This curious transformation is instructive in another way. It is not operated by light, at least not by light alone. *A certain temperature* must be attained, and that temperature suffices in total darkness. Nevertheless, I find that on exposing to a very concentrated spectrum (collected by a lens of short focus) a slip of paper duly prepared as above (that is to say, by washing with the mixed solutions, exposure to sunshine, washing, and discharging the uniform blue color so induced as in the last article), its whiteness is changed to brown over the whole region of the red and orange rays, *but not beyond* the luminous spectrum. Three conclusions seem unavoidable: First, that it is the heat of these rays, not the light, which operates the change; secondly, that this heat possesses a peculiar chemical quality which is not possessed by the purely calorific rays outside of the visible spectrum, though far more intense; and thirdly, that the heat radiated obscurely from hot iron abounds especially in rays analogous to those of the region of the spectrum above indicated." (See *Blue Print*, etc.)

Cycloramic Camera. A "panoramic" camera invented by Percy S. Marcellus, Philadelphia. (See *Marcellus' Cycloramic Camera* for engraving and full description.)

Cylindrograph. A panoramic camera, constructed by P. Moëssard, for portraits, groups, landscape and shutter exposures. Admits of taking pictures of 170 degrees in dimension. The shields or carriers can be bent semicircularly and are arranged for films that may be bent. Can be used for topographic exposures. For details of the various forms of panoramic cameras, see *Brit. Journ. Almanac*, 1892.

D.

Daguerrean (Daguerrian). One who practises the daguerrotype art.

Daguerrotype. The name applied to the original photographic discovery of MM. Daguerre and Niepce on silver tablets. The art of impressing objects distinctly and permanently on silver plates. This discovery was first announced to the public of France in 1839. The first to take portraits from life by this process were Professors Draper, Morse, and Walcott, of New York. Prof. Draper increased the sensitiveness of the plate by the use of chlorine gas, and subsequently (1840) Mr. Claudet, of London, added the chloride of iodine to the bromine previously applied by Mr. Goddard, of England. Since that time the art has made wonderful advancement, and in no part of the world has it made such rapid strides as in the United States, where its perfection of manipulation, truthfulness to Nature, exquisite tone, delicacy of tint, and beauty of finish, places by general consent the American operator in the first rank of the art. The *daguerrotype process* now consists of seven distinct operations. (The silvered plate is prepared in large quantities by manfacturers.) 1. *Cleaning and polishing the plate:* For this it is necessary to have plate blocks, plate vice, spirit lamps, buffs (hand or machine), nitric acid, alcohol, rottenstone, rouge, and prepared cotton-wool or cotton flannel. (See *Cleaning the Plate.*) 2. *Galvanizing the plate:* Requiring a Sinn's or Daniels' galvanic battery, a solution jar, dilute nitric acid, a plate of pure silver, chloride and cyanide of silver. (See *Galvanizing the Plate.*) 3. *Sensitizing the plate:* Requiring an iodine box, bromine box, re-sublimed iodine, bromide of lime, or other accelerating substance. (See *Sensitizing the Plate.*) 4. *Exposition of the plate to light:* Requiring the photographic camera. (See *Exposition of the Plate.*) 5. *Bringing out the picture*, or *mercurializing:* Requiring the mercury bath with thermometer, perfectly pure mercury, and a spirit lamp. (See *Bringing Out the Picture.*) 6. *Fixing the image:* Requiring hyposulphite of soda, a porcelain dish and bowl, a pair of pliers or forceps, and a spirit lamp. (See *Fixing the Daguerrean Image.*) 7. *Gilding the picture:* Requiring chloride of gold or auro-

chloride of sodium, or hyposulphite of gold, a pair of pliers, a gilding stand, and a spirit lamp. (See *Gilding the Picture.*)

The *practical* details of the daguerrotype process are described under their appropriate heads in the various parts of this work, as they are entirely distinctive from all other photographic processes, and as they will be more readily referred to. The *theoretical* details alone are given here. A copper plate of moderate thickness is coated upon one surface with a layer of pure silver; it is then polished with great care until the surface assumes a brilliant metallic lustre. This preliminary operation of polishing is one of great practical importance. After the polishing is complete the plate is ready to receive the sensitive coating. This part of the process is conducted in a peculiar manner. By exposing the polished surface over iodine the vapor attacks the silver, which in a short time acquires a pale-violet hue, due to the formation of an excessively thin layer of iodide of silver. By prolonging the action of the iodine the violet tint disappears and a variety of prismatic colors are produced, much in the same way as when light is decomposed by thin plates of mica or the surface of mother-of-pearl. From violet the plate becomes of a straw-yellow, then rose-color, and afterward steel-gray. By continuing the exposure the same sequence of tints is repeated; the steel-gray disappears, and the yellow and rose recur. The deposit of iodide of silver gradually increases in thickness during these changes, but to the end it remains excessively thin and delicate. In this respect it contrasts strongly with the dense, creamy layers often employed in the collodion process, and shows that a large portion of the iodide of silver must in such a case be superfluous, as far as any influence produced by the light is concerned. An inspection of a sensitive daguerrotype plate reveals the microscopic nature of the actinic changes involved in the photographic art, and teaches a useful lesson. The original process of Daguerre was conducted with the vapor of iodine only; but it was discovered by Mr. Goddard that the sensibility of the plate was greatly promoted by exposing it to the vapors of iodine and bromide in succession, the proper time for each being regulated by the tints assumed. The composition of this bromo-iodide of silver, so called, is uncertain and has not been proved to bear any analogy to that of the mixed salt obtained by decomposing a solution of iodide and bromide of potassium with nitrate of silver. Observe also that the bromo-iodide of silver is more sensitive than the simple iodide *only when the vapor of mercury is employed as a developer.* M. Claudet proved that if the image is formed by the direct action of the light alone, the usual condition is reversed, and that the use of bromine under such circumstances retards the effect. The latent image of the daguerrotype is developed in a manner different from that of the humid processes generally, viz., by the action of mercurial vapor. Mercury is a metallic fluid which boils at 662° Fahrenheit. We are not, however, to suppose that the iodized plate is subjected to a temperature at all approaching to 662°. The cup containing the mercury is previously heated by means of a spirit lamp to about 140°, a temperature easily borne by the hand in most cases without inconvenience. The amount of mercurial vapor evolved at 140° is very small, but it is sufficient for the purpose, and after continuing the action for a short time the image is perfectly developed. There are few questions which have given rise to greater discussion amongst chemists than the nature of the daguerrotype image. Unfortunately, the quantity of material to be operated on is so small that it becomes almost impossible to ascertain its composition by direct analysis. Some suppose it to consist of mercury alone. Others have thought the mercury is in combination with metallic silver. The presence of the former metal is certain, since M. Claudet showed that by the application of a strong heat it can actually be volatilized from the image in sufficient quantity to develop a second impression immediately superimposed. It is a remarkable fact that an image more or less resembling that developed by mercury can be obtained by the *prolonged action of light* alone upon the iodized plate. The substance so formed is a white powder, insoluble in solution of hyposulphite of soda; amorphous to the eye, but presenting the appearance of minute reflecting crystals when highly magnified. Its composition is uncertain. For all practical purposes the production of the daguerrotype image by light alone is useless, on account of the length of time required to effect it. Pure

homogeneous yellow light has no action upon the daguerrotype plate; but if the iodized surface be first exposed to white light for a sufficient time to impress a latent image, and then afterward to the yellow light, the action already commenced is continued (see *Continuating Glasses*), and even to the extent of forming the peculiar white deposit, insoluble in hyposulphite of soda, already alluded to. Yellow light may, therefore, in this sense be spoken of as a developing agent, since it produces the same effect as the mercurial vapor in bringing out to view the latent image. A singular anomaly, however, requires notice, viz., that if the plate be prepared with the mixed vapors of bromine and iodine in place of iodine alone, then the yellow light cannot be made to develop the image. In fact, the same colored ray which continues the action of white light upon a surface of iodide of silver actually destroys it, and restores the particles to their original condition, with a surface of bromo-iodide of silver. These facts, although not of great practical importance, are interesting in illustration of the delicate and complex nature of the chemical changes produced by light. The use of chloride or hyposulphite of gold to whiten the daguerrotype image and render it more lasting and indestructible was introduced by M. Fizeau. After removal of the unaltered iodide of silver by hyposulphite of soda, the plate is covered with a solution of hyposulphite or chloride of gold. The flame of a spirit lamp is then applied until the liquid begins to bubble. Shortly a change is seen to take place in the appearance of the image; it becomes whiter than before, and acquires great force. This fact seems to prove conclusively that metallic mercury enters into its composition, since a surface of silver—such, for instance, as that of the collodion image—is darkened by hyposulphite of gold. The difference in the action of the gilding solution upon the image and the pure silver surrounding it illustrates the same fact. This silver, which appears of a dark color and forms the shadows of the image, is rendered still darker, a very delicate crust of metallic gold gradually forming upon it, whereas with the image the whitening effect is immediate and striking.—*H. H. Snelling.*

Daguerrotype Film. The sensitive film of the daguerrotype is different in many respects from that of the calotype or collodiotype. The latter may be termed *wet processes*, in contradistinction to the former, where aqueous solutions are not employed. The daguerrotype film is a pure and isolated iodide of silver, formed by the direct action of the iodine upon the silver. Hence it lacks one element of sensitiveness possessed by the others, viz., the presence of soluble nitrate of silver in contact with the particles of iodide of silver. It is important to remember that the iodide of silver prepared by acting with vapor of iodine upon metallic silver is different in its photographic action from the yellow salt obtained by double decomposition between iodide of potassium and nitrate of silver. A daguerrotype film, when exposed to bright light, first darkens to an ashy-gray color and then becomes nearly white; the solubility in hyposulphite of soda being at the same time lessened. A collodion film, on the contrary, if the excess of nitrate of silver be washed off, although it is capable of receiving the radiant impression in the camera, does not alter either in color or solubility by exposure even to the sun's rays.

Dallastype. A photo-electric engraving and etching process, discovered by Duncan C. Dallas, for making cuts or blocks for book- and copper-printing presses.

Dallmeyer's Triple Achromatic Lens. As its name indicates, this lens is the invention of Mr. J. H. Dallmeyer, of London. It has a focal length of about 18 inches, and consists of three achromatic combinations; the front and back are "positive;" the former 2¼ inches, the latter 3¼ inches in diameter. Between the two is situated an achromatic "negative" combination of 1½ inch diameter. Each of the three has its contact surfaces cemented, and therefore the total number of "reflecting" surfaces does not exceed those of the portrait lens. The "negative" combination is of such form and focal power as are required for the correction of the central and excentrical pencils, and with full aperture (1½ inch, or rather 1¾ inch—for the rays, after refraction by the front "positive," are convergent upon the second or "negative" combination, which constitutes the limiting aperture) the lens is free from spherical and chromatic aberration both at the centre and margin of the picture, and the field is flat. With the whole aperture, the lens covers a plate 10 x 10 inches, equally illuminated to the corners. With 1 inch

aperture, it covers a plate 12 x 12. When the "negative" combination is removed, the focal length of the lens is reduced to 8 inches, and works in about the same time as the ordinary portrait lens; but the field is not so flat.

Damaskeening. The art of beautifying iron or steel by engraving and inlaying with gold and silver wire. (See *Heliographic Damaskeening.*)

Dammar. Syn., Gum dammar. A resinous substance obtained from the Amboyna pine in the East Indies; yellowish in color, and odorless; soluble in turpentine, alcohol, chloroform, and benzole. Used as a basis in the preparation of photographic varnishes. A weak solution of gum dammar in turpentine forms an excellent retouching varnish.

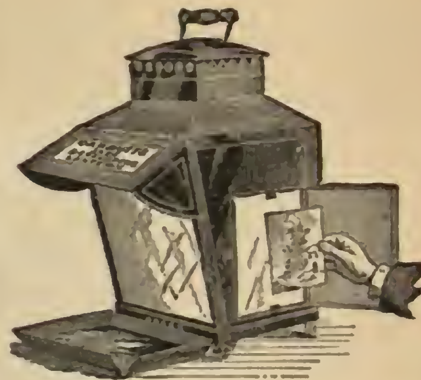
Dark Chamber. This term is sometimes applied to the camera box, and is, therefore, synonomous with it. (See *Camera.*)

Darken. The change which photographic paper undergoes when submitted to the light for the production of the shadows.

Dark-Room. The room in which the sensitive materials used in photography are manipulated is called the dark-room. Much of the pleasure and quality of photographic work depends upon the convenience of the dark-room, the construction and arrangement of which should have careful consideration. A model dark-room should be not less than 10 x 8 feet in dimensions; preferably lighted from the north as freely as is consistent with safety in manipulation; the windows should be glazed with yellow or ruby glass, or a combination of a sheet of cathedral-green between two canary-tinted glasses will be found less injurious to the eyesight of the operator. The light so admitted to the dark-room should be frequently tested as to its safety. Where artificial light is used it should be screened with glass similar to that used in the windows. With orthochromatic plates deep ruby light is preferable. The furnishings of a dark-room should include a roomy sink for development, with a plentiful supply of water, a table, and a convenient shelf for the fixing and clearing baths, with shelves and lockers for chemicals, holders, and other requisites. The ventilation of the dark-room should be looked after; and the room should be frequently cleaned with a damp cloth or mop.

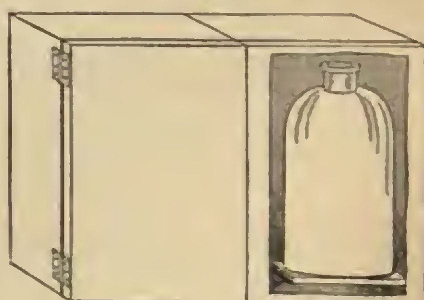
Dark-Room Lantern. There are many inventions for protecting the sensitive plates from light. The contrivance shown in Fig. 61 is the invention of Mr. John Carbutt, and is one of the many forms in use.

FIG. 61.



Dark-Room Illuminator. Devised by Mr. A. M. de Silva. (See Fig. 62). Very many failures are occasioned by the miserable light of the dark-room. Anyone with a little ingenuity and at a trifling cost, can fit up quite a brilliant light into the window of the chemical

FIG. 62.



room. By taking a small packing-case, cutting the bottom in half, so as to form a door to admit daylight when desired, and fitting into the other half one or more five-pound bottles filled with a saturated solution of bichromate of potash, a perfectly safe light is obtained. The cut represents the light as seen from the *inside* of the room. After the piece is sawed out, so that nearly the half of the bottle will set in it, a piece of cloth is

stretched tightly over it; a cut is made in it so that the bottle rests snugly into it, thus preventing the light from passing through the outer edges, the bottom being supported by a board with small strips nailed around, to cut off the light from the bottom of the bottle. The bottles should *not* be corked; use a piece of glass laid on the top, to keep out the dust. While developing gelatine plates a piece of ruby glass can be placed between the bottle and the light in a minute, the light from which is much more comfortable for the eyes than the glimmer of a little lamp, or the ruby paper, through which you can see nothing. If the window faces the sun, it will be found a very convenient warming-closet for the developer.

Dark-Slide. This term is applied to the shield which holds the daguerrotype or glass plate for exposition in the camera.

FIG. 63.

Dark Tent. Fig. 63 shows the interior of the dark tent used by outdoor operators when photographers employed the wet-plate process. Photography of to-day does not require such a device, since dry plates have made it unnecessary. The diagram shows the dipping-bath and bottles and the operator in the act of pouring the solution upon the plate. It was necessary for him to carry from 50 to 65 pounds of this sort of paraphernalia when working in the field.

Dead Background for Glass Positives. To produce this effect, take of ultramarine 24 grains; loaf sugar 7 grains; gum arabic 6 or 7 drops; ox-gall 4 or 5 drops. These ingredients should be mixed together on a piece of plate glass, ground on the side you intend to work. Having put your colors, etc., on the glass, you must get something to grind them with: a piece of polished agate, or a lump of glass with one smooth surface will answer very well. With this grind all together until they are thoroughly mixed and very fine. After you have done this get a sable pencil of moderate size, take up some of the color from the glass, and go around the edge of the portrait on one side, and then work from the portrait to the edge of the glass; then do the other side the same. You must now leave your picture to dry, which it will do in about a minute; when dry, take a dry sable pencil and go over the ground with the powder dry color of the tint you wish the ground to be. If you wish a very fine ground you must grind your dry colors with a little Canada balsam and turpentine, and with this work over your background instead of the plain colors, but be sure not to let it touch the head or dress of the figure or you will spoil your picture.

Decant. To pour off the clear supernatant liquid from the settlings in a dish or bottle, without filtering.

Declinometer. An instrument for measuring the declination of the magnetic needle.

Decolorizing Albuminate of Silver. The silver solution upon which albumen paper is floated, for the purpose of sensitizing it, gradually becomes colored of a brownish tint, by portions of albumen dissolving off the paper. The process by which this coloration is destroyed and the solution rendered clear again, is termed "decolorizing." Filtering through animal charcoal and kaolin (China clay) has been recommended, but Mr. J. G. Tunny has discovered the following process, which is much more effective. Take the discolored bath and carefully add a few drops of a saturated solution of citric acid; the first drop will at once indicate if it

has combined with the silver. If a white, curdy deposit does not take place, add a drop of liquor ammonia, which will at once produce the effect. It may be advisable to add a few drops more of the acid. This, to a certain extent, has to be regulated by the amount of coloring matter present in the bath. This can be easily ascertained by seeing if the fluid passes through the filter clear. If it is found that the color has not been entirely discharged, a drop or two more of acid may be put into the bath; but let it be observed, each drop produces its certain amount of citrate of silver. If it does not, then a drop of ammonia must be resorted to. The whole must then be filtered through some common filtering-paper. This operation requires great care; for if too much citric acid be added a very large addition of ammonia will be required, and the consequence is considerable waste of silver, from the large amount of citrate of silver left on the filter. This, however, may be rendered serviceable by re-dissolving it with aqua ammonia and using it for plain paper printing. If this application of citric acid be judiciously made, it is surprising what little waste will be incurred to produce such a wonderful result. The bath in its neutral or alkaline state will at once allow of the citrate of silver being formed on the addition of the first drop of citric acid; on the contrary, if the bath is acid, no such formation will take place, and the anxious expectant will be disappointed unless the ammonia is used.

Decompose. To separate the constituents of a body or substance.

Decomposition. Analysis; the art of separating the constituent parts of a compound body or substance. Decomposition differs from mechanical division, as the latter effects no change in the character of the body divided, whereas the parts decomposed have properties very different from those of the substance itself. Decomposition is effected by light, heat, and chemical action. The decomposition of the sensitive surface by light is one of considerable importance to the photographer; we therefore quote Mr. Hardwick's remarks on this subject:

"Sensitive papers, prepared with the chloride of silver in the manner above directed, will naturally contain a considerable quantity of this salt, distributed not only upon the surface but also in the substance of the paper. It must not, however, be imagined that the *whole* of this chloride, or indeed anything approaching thereto, is affected by the luminous radiations. The darkening which takes place is *exceedingly superficial*, and although the black color may be intense, yet the amount of reduced silver which goes to form it is so small that it cannot conveniently be estimated by chemical reagents.

"Now a knowledge of the almost infinitesimal nature of the changes which take place in photography is practically useful, because it leads us to pay more attention to the condition of the *surface* of the sensitive salt, in contradistinction to the layer which lies immediately beneath.

"It is particularly important to bear such a fact in mind in the preparation of the more sensitive papers containing the *iodide of silver*, and intended to be used in conjunction with a 'developer' but it is also useful in the case of the ordinary chloride of silver paper just described.

"For instance, if in preparing such paper the sheet be allowed to remain upon the salt solution until it is thoroughly saturated in every part, and then it be hung up by means of a pin to dry, the superficial stratum of liquid does not sink into the substance of the paper, but evaporates and leaves behind a layer of saline particles, which are certainly not favorably situated for subsequent photographic action.

"On the other hand, if the sheet be removed at a somewhat earlier period, this same stratum of liquid is absorbed more or less completely, and the formation of a *crust* is avoided.

"The kind of surface which it is desirable to obtain is just such a one as would be left after 'blotting off' between sheets of bibulous paper, that is to say, a surface neither wet nor dry, but in an intermediate state; moist at first, and afterward, when the evaporation is complete, leaving the particles in a fine state of division, and each one in contact with organic matter."

Deepening. Intensifying; creating greater strength of color; giving more vigor or force to the shadows of a negative or positive. This is effected by re-developing with pyrogallic acid and silver; protosulphite of iron, acetic acid, and silver; or by the various methods of intensifying. (See *Re-developing and Intensifying.*)

Deepest Shadows. The darkest parts of a photograph, represented in the negative by nearly clear glass.

Deliquesce. To melt gradually and become liquid by attracting and absorbing moisture from the atmosphere.

Density. Closeness of constituent parts; compactness. Density is opposed to rarity, and in philosophy the density of a body indicates the quantity of matter contained in it under a given bulk. If a body of equal bulk with another is of double the density, it contains double the quantity of matter. Photographers often mistake *intensity* for *density*, which often leads to poor results in the negative process. By comparing *this* definition with *that* for *intensity*, they will readily see their error. In *deepening* a photographic negative, *density must* accompany *intensity*, or sufficient opacity will not be obtained to make the negative a good printing medium.

Dephlogisticated Air. An elastic fluid capable of supporting animal life and flame much longer than common air. (See *Oxygen*).

Fig. 64a.

Fig. 64b.

Fig. 65.

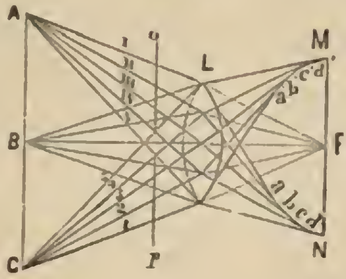
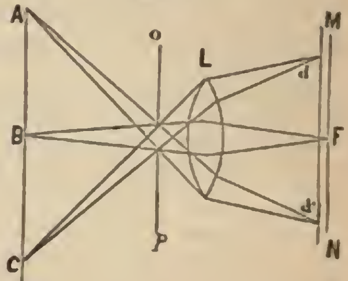
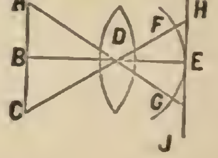


Fig. 66.



Depth of Focus. The property of a lens to give a tolerably clear image of objects not in one plane. Fig. 64a and Fig. 64b will make it plain. In Fig. 64a we make use of the whole aperture of a lens, D. R R are parallel rays, striking the margin of the lens. The image is formed at a screen, A; if the screen is moved to B or C, the image of the point *a* spreads out, because the angle of the crossing rays is large. When the same lens, D (Fig. 64b), is provided with a diaphragm, so as to reduce the aperture considerably, the focus of the rays R R is still at *a*. If we now move the screen the same distance as before, to C or B, we find that the image of the point *a* is considerably reduced. If we now look at Fig. 67, we see that only E can be sharp on the screen, and if the screen be moved toward the lens until the points F and G are sharply defined upon it, then the point E will lie beyond the screen and become indistinct; but if we provide the lens with a small central diaphragm, we can find a place for the screen where all three points can be brought to it, without the images being sensibly diminished in sharpness. Now, let us see what takes place if we move the diaphragm to a proper distance from the lens. A, B, C (Fig. 65) are distant points, L a converging lens. Let us trace the course of the rays, commencing from the points A, B, C. The rays from the point B, situated in the axis, and the image of the point B will be formed at F, the principal focus. But it is different with the rays coming from A and C. The rays proceeding from the point A (A i, A ii, A iii, A iv, A v), are refracted to *a*, *b*, *c*, *d*, *e*; similarly, the rays from

Fig. 67.



the point C are refracted to *a′*, *b′*, *c′*, *d*, *e′*, occasioning, as we have seen before, spherical aberration. If we place a screen at the principal focus, F, it will not receive a dis-

tinct image, even if we have a concave screen; as will be observed, all the rays outside of the axis arrive at different distances behind the lens. You notice that none but the rays A IV and A V, C_4 and C_5, have their foci near the plane of the screen M N. Now if we find a place for a diaphragm, so that only these rays pass the lens, and the depth of the lens is as great as *d* M (Fig. 66), we may expect a pretty sharp image on a plane screen. By looking over the figure, we see that such a plane is in O P (Figs. 65 and 66). A diaphragm in this place, and of the proper size, will allow only the most favorable rays to pass, and a tolerably flat and sharp image is obtained. The smaller the diaphragm the sharper and flatter the image. But as we mentioned before, small diaphragms have the disadvantage that the light is cut off to so large an extent; and for most purposes the lens becomes useless. But suppose we would employ a negative lens, under the same conditions, we would have no real image, but a virtual one, the curvature of the field would be reversed, and the marginal rays have a longer focus than the central ones. Therefore, it is possible to associate a negative with a positive lens and to render the field flat.

Desiccate. To dry; to exhaust of moisture; to become dry.

Desiccating Box. A box for the purpose of preserving sensitive photographic paper; invented by Mr. Spiller, of England. The construction of the box is very simple. It consists of an oblong pine-wood chest, raised a little from the floor by being made to rest on two battens. It has a rim cover with a tolerably deep rim on all sides to guard against the possibility of light entering; and within the box, covering the entire area of the bottom, is a shallow wooden tray for holding the supply of quick-lime. Above the tray is fitted a wooden partition, perforated with numerous small holes and clamped to prevent warping. This is readily lifted out when it is necessary to renew the lime. In its place it constitutes a false bottom on which to lay the prepared paper after it has been air-dried. The perforated bottom and the interior of the box above it should be well blackened; but with the lime tray this is unnecessary. The lime should be put in in unslaked lumps and should be renewed when these lumps have all become slaked or reduced to powder.

Desiccation. Drying.

Detail in the Shadows. The darkest parts in the shaded portions of a picture, which must have sufficient exposure in order to show themselves on the plate. A picture showing these details is called a fully-exposed one.

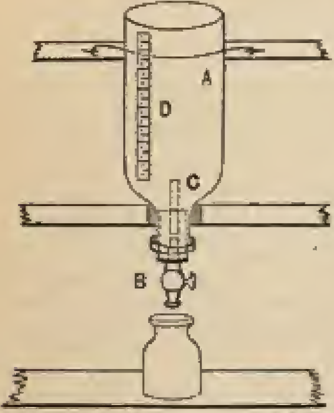
Detective Cameras. Many forms of the hand-camera are so constructed as to appear unlike the ordinary photographic camera familiar to the public; such are generally called detective cameras, and may be used in public without attracting attention. One camera of this kind is concealed within an ordinary hand-bag of convenient size; another in a watch-case or purse, or contained within the frames of a field-glass, etc. These fanciful forms are not, however, as commonly used as the ordinary hand-camera, consisting of a complete camera, lens, etc., incased in a neat leather cover without outside fittings or appurtenances. Details of the various forms of hand-cameras may be seen by reference to the catalogue of any dealer in photographic apparatus.

Detergents. The name given to mixtures used for cleaning glass, etc. For cleaning plain glass a solution of alcohol 100 ounces, tripoli 5 ounces, and iodine 1 ounce, is generally employed. To remove old films from gelatine negatives a saturated solution of washing soda is excellent; to remove old collodion films 1 ounce of nitric acid in 6 ounces of water is recommended, while for cleaning opal glass a two per cent. solution of caustic soda is used.

Developer. The name given to any chemical agent which makes visible the latent image on any sensitive surface, or which develops out a faintly impressed image obtained upon a positive paper. Developers are generally classed as acid or alkaline, according to their nature, or their reaction with the sensitive surface employed. The principal developers used in the development of gelatino-bromide plates are ferrous oxalate, pyrogallol, hydroquinone, eikonogen, amidol, paramidophenol, hydroxylamine, catechol, metol, and glycin; for bromide papers, ferrous oxalate, pyro-hydroquinone, hydroxylamine, eikonogen, ferrous citrate or acetate, amidol, metol, or glycin may be used; for positive chloride emulsion papers, pyrogallol, gallic acid, and metol are recommended. These may be found referred to under their respective headings.

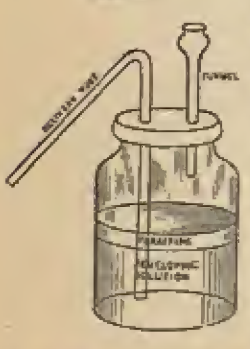
Developer-Holder. Consisting of a two-pound bottle with the bottom removed and corked tightly. B is a small faucet connecting with the interior of the bottle by a short glass tube, C; D is a scale made of paper pasted outside. It is all used as follows: Pour in water to fill up to the top of the tube C, where, of course, all excess will

FIG. 68.



overflow. Make a mark upon the strip of paper where the water now stands. This is zero. Close the faucet now thoroughly, pour 16 ounces of water into the bottle, and mark the lever upon the paper strip, and then divide down to zero with dividers into sixteen spaces. This will represent ounces; number them accordingly.

FIG. 69.



Developing Bottle. This apparatus is for preserving the ferrous oxalate developer from the action of the air. It consists of a wide-mouth bottle, in the cork of which are inserted two tubes. One tube is bent for the delivery of the solution into a tray when required for use. The other one is a thistle-mouthed funnel through which to pour the solution back into the bottle. A layer of paraffin protects it from the air. In using this bottle the mouth of the operator is applied to the funnel and air is blown through it to expel the liquid through the delivery tube.

Developing Plate-Holder. An instrument for holding the plate during development, for the purpose of avoiding staining. It consists of a shank of stout silver-plated wire, at one end of which is a ring which forms the handle, and at the other a fixed gutta-percha rest or holder. Opposite to this is another shoulder of gutta-percha, which slides along the wire. Stretched over the fixed and the movable shoulder is a vulcanized India-rubber band. In each piece of gutta-percha is an aperture, so that when a plate is placed with one corner in each gutta-percha rest diagonally, it only touches at the extreme edges. The plate is held firmly in this position by the India-rubber band, which by its elasticity holds with equal facility any size, from a quarter plate to a whole plate, or larger. The contrivance is light, compact, efficient, and cheap, and will completely realize the possibility of photography with clean fingers.

Developing Solution. Solutions for the development or bringing out of the latent photographic image by the wet process. Almost every photographer has a formula peculiar to himself for making this solution. The ones given below are merely examples. There is no end to the modifications and material used.

Negative Formula, 1:

Water	20 ounces.
Protosulphate of Iron . . .	1 ounce.

Dissolve and filter, and, as required for use, to every 8 ounces of the solution add 2 ounces of acetic acid No. 8, and 1 ounce 95° alcohol. If this solution acts too rapidly, lessen the proportion of protosulphate of iron; if too slow add more of the salt.

Negative Formula, 2:

Water	16 ounces.
Protosulphate of Iron . . .	320 grains.
Glacial Acetic Acid . . .	320 drops.
Alcohol	160 "

Negative Formula, 3:

Water	12 ounces.
Pyrogallic Acid	9 grains.
Glacial Acetic Acid	3 drachms.

Negative Formula, 4:

Water	1 ounce.
Pyrogallic Acid	1 grain.
Glacial Acetic Acid	10 to 20 drops.
Alcohol	10 drops.

Positive Formula, 1:

Water	16 ounces.
Protosulphate of Iron	320 grains.
C. P. Nitric Acid	320 drops.
Alcohol	10 "

Positive Formula, 2:

Water	1 ounce.
Sulphate of Iron	15 grains.
Nitrate of Potash	10 "
Glacial Acetic Acid	20 minims.
Alcohol	30 "

Positive Formula, 3:

Water	1 fluidounce.
Nitric Acid	1 drop.
Pyrogallic Acid	2 grains.

Positive Formula, 4:

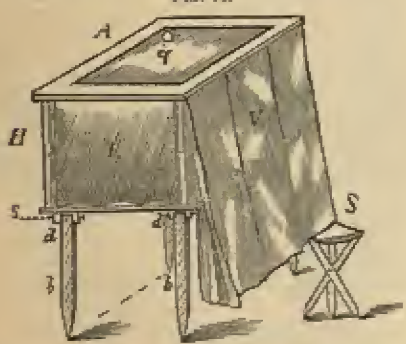
Water	1 quart.
Protosulphate of Iron	2 ounces.
Acetic Acid, No. 8	2 "
Nitric Acid	½ ounce.
Alcohol	1 "

Positive Formula, 5:

Protosulphate of Iron	1 ounce.
Nitrate of Potash	¾ "
Acetic Acid, No. 8	3 ounces.
Water	1 quart.

All these solutions must be filtered before use, and should be mixed as directed for No. 1 negative formula. (See *Printing by Development.*)

Fig. 70.



Developing Tent. One of many contrivances used for changing and developing plates in or out of doors. It is constructed of a wooden frame and may be covered with rubber or black muslin lined with yellow to secure darkness. At *P* a transparent color-screen is placed. The curtain, *V*, is made to wrap about the person of the operator so as to exclude all light.

The arrangements for waste are at *d d*, and *S* is the seat.

Development. The operation of making visible the image impressed by light upon any sensitive surface employed in photography is called development; this operation is necessarily done in non-actinic light in the dark-room. The method of development in this or that process varies according to the sensitive surface and developing agent used, and may be found in detail under the headings of the several processes. The general theory of development in the commonly used gelatino-bromide process of negative-making may be briefly summarized as follows: When a gelatino-bromide plate is exposed to the action of light the sensitive film undergoes a change, the elements of which it is composed (silver and bromine) losing their affinity for each other, and a state of incipient decomposition is set up. If an exposed film is subjected to the action of a reagent which has a reducing power over the modified silver bromide, the action of light upon the film is continued and intensified by the further decomposition of the molecules of the film impressed by light. This continuing action constitutes development, and by it the image impressed on the film is made visible, a dark deposit of silver resulting from the application of the developer or reducing agent in those parts of the film affected by light in proportion to the intensity of the light action. When the action of the reducing agent is too strong we have a general reduction of silver over the entire sensitive surface, resulting in what is known as fog.

"*Development of the Image.* The action of the developing solutions upon the film after exposure to light, by which the latent image is made visible. It has been shown that the continued action of light upon certain salts of silver results in the separation of elements like chlorine and oxygen, and the partial reduction of the compound. It is also known that bodies possessing affinity for oxygen, such as sulphate of iron and pyrogallic acid, tend to produce a similar

effect; acting in some cases with great energy and precipitating metallic silver in a pure state. In forming an extemporaneous theory on the production of the latent image in the camera, it would therefore be natural to suppose that the process consisted in setting up a reducing action upon the sensitive surface by means of light, afterward to be continued by the application of the developing solution. This idea is, to a certain extent, correct; but it requires some explanation. The effects produced by the light and the developer are not so precisely similar that the one agency can always be substituted for the other; an insufficient exposure in the camera cannot be remedied by prolonging the development of the image. In the photographic process on paper it is indeed found that a certain latitude may be allowed; but as a rule, it should be stated that a definite time is occupied in the formation of the visible image, which may not be shortened or extended beyond its proper limits with impunity. There is a maximum point beyond which no advance is made; hence if the plate be not then removed from the camera, those portions of the image formed by the brightest lights are speedily overtaken by the "half-tones," so that, on developing, an image appears without that contrast between lights and shadows which is essential to the artistic effect. On the other hand, in case of insufficient exposure, the feeble rays of light not having been allowed time to impress the plate, the half-shadows cannot be brought out on subsequent treatment with the developing agent. A careful study of the phenomena involved in this part of the process cannot fail to show that the ray of light determines a *molecular* change of some kind in the particles of iodide of silver forming the sensitive surface. This change is not of a nature to alter the composition or the chemical properties of the salt. The iodine does not leave the surface, or there would be a difference in the appearance of the film, or in its solubility in the hyposulphite of soda.

No image can be produced on the application of pyrogallic acid unless the particles of iodide are in contact with nitrate of silver; and hence it may be the nitrate and not the iodide which is reduced—that is, the impressed molecule of iodide may determine the decomposition of a contiguous particle of nitrate, itself remaining unchanged. This view is supported to some extent by Moser's experiments, and also by the fact that the delicate image first formed can be intensified by treating it with a mixture of the developing solution and nitrate of silver, even after the iodide has been removed by the fixing agent. (See *Re-development; Intensifying*, etc.) Now it is evident that the additional deposit upon the image is produced from the nitrate of silver, the whole of the iodide having been previously removed. Observe, also, that it forms only upon the image and not upon the transparent parts of the plate. Even if the iodide untouched by light be allowed to remain, the same rule holds good; the pyrogallic acid and nitrate of silver react upon each other and produce a metallic deposit; this deposit, however, has no affinity for the unaltered iodide upon the part of the plate corresponding to the shadows of the picture, but attaches itself in preference to the iodide already blackened by light. This second stage of the development, by which a feeble image may be strengthened and rendered more opaque, is sometimes termed "development by precipitation," and should be correctly understood by the practical operator. Several conditions affect the development of the latent image which it may be well to explain: 1. The presence of free nitrate of siver is essential. A sensitive collodion plate, carefully washed in water, is still capable of receiving the radiant impression in the camera, but it cannot be developed until it has been re-dipped in the nitrate bath, or treated with a reducing agent to which nitrate of silver has been added, and if the proportion of free nitrate of silver in the collodion be too small, the image will be feeble, or altogether imperfect in parts, with patches of green or blue, due to deficient reduction. 2. No increase of power in a developer will suffice to bring out a perfect image on an under-exposed plate, or upon a film containing too little nitrate of silver. But there is considerable difference in the length of time which the various developers require to act. Gallic acid is the most feeble and pyrogallic acid the strongest. 3. Acids tend to retard the reduction of the image as well as to diminish the sensibility of the film to light. Nitric acid especially does so. The effect of nitric acid is particularly seen when the film of iodide of silver is very blue and transparent, and the quantity of nitrate of silver retained upon the surface small.

This indicates that the quantity of the acid should be diminished, or the strength of the nitrate bath or reducing agent be increased, as a counterpoise to the retarding action of the acid upon the development. Acetic acid also moderates the rapidity of development, but it has not that tendency altogether to suspend it possessed by nitric acid. On comparing the retarding effects of free acid upon the light's action, and upon the development, we see that the former is most marked—that a small quantity of nitric acid produces a more decided influence upon the impression of the image in the camera than upon the bringing out of that image by means of a developer. 4. Organic bodies, like albumen, gelatine, glycyrrhizin, etc., which combine chemically with oxides of silver, and lessen the sensitiveness of the iodide film, facilitate the development of the image, producing often a dense deposit of a brown or black color by transmitted light. 5. The physical structure of the collodion film exerts an influence upon the mode in which the reduced silver is thrown down during the development. A short and almost powdery state, such as collodion iodized with the alkaline iodides acquires by keeping, is considered favorable, and a glutinous, coherent structure unfavorable, to density. This is certainly the case where the film is allowed to dry before development, and in the processes with desiccated collodion, and, to some extent, in the oxymel process. 6. The mode of conducting the development also affects the density, a rapid action tending to produce an image of which the particles are finely divided and offer a considerable resistance to the passage of light, whilst a slow and long development often leaves a metallic and almost crystalline deposit, comparatively translucent and feeble. 7. The actinic power of the light at the time of taking the picture influences the appearance of the developed image, the most vigorous impressions being produced by a strong light acting for a short time. 8. Of the three principal salts of silver, the iodide is the most sensitive to light, but the bromide and chloride, under some conditions, are more easily developed and give a darker image. 9. If the exposure in the camera be prolonged beyond the proper time, the development takes place rapidly but without intensity. The effect produced by over-action of light is particularly seen when the nitrate bath contains nitrate of silver or acetate of silver; the image being frequently in such a case dark by reflected light, and red by transmitted light. 10. A peculiar condition of the nitrate bath, in which the collodion image develops unusually slowly and has a dull-gray metallic appearance, with an absence of intensity in the parts most acted upon by light. This condition, which occurs only when using a newly mixed solution, depends upon the presence of an oxide of nitrogen retained by the nitrate of silver. It is removed by adding an excess of alkali followed by acetic acid; but most completely by carefully fusing the nitrate of silver before dissolving it. Greater intensity is commonly obtained in a nitrate bath which has been a long time in use, than in a newly mixed solution. This may be due to minute quantities of organic matter dissolved out of the collodion film, which, having an affinity for oxygen, partially reduces the nitrate of silver; and also to the accumulation of alcohol and ether in an old bath, producing a short and friable structure of the film. 11. Temperature has considerable influence upon the development of the image. In cold weather the development of the image is slower than in warm, and consequently it is necessary to increase the strength of the reducing agent and add more free nitrate of silver, to produce the desired effect. If, in hot weather, the ordinary developer works too rapidly, the remedy is to use acetic acid freely both in the developing solution and in the nitrate bath, at the same time lessening the quantity of the developer and omitting the nitrate of silver which is sometimes added toward the end of the development. In the case of films which are to be kept for a long time in sensitive condition, the modifying influence of temperature must be observed and the quantity of free nitrate of silver be reduced, if the thermometer stands higher than usual. The characteristics of proper development are that the action of the reducing agent should cause a blackening of the iodide in the parts touched by light, but produce no effect upon those which have remained in shadow. In operating both on collodion and paper, however, there is liability to failure in this respect; the film beginning, after the application of the developer, to change in color to a greater or less extent over the whole surface. There are two main causes which produce this state of

things: the first being due to the irregularity in the action of the light, the second to a faulty condition of the chemicals employed. If from a defect in the construction of the camera, diffused light gains entrance into the camera, it produces indistinctness of the image by affecting the iodide more or less universally. The luminous image of the camera not being perfectly pure, mere over-exposure of the sensitive plate will usually have the same effect. In such a case, when the developer is poured on, a faint image first appears, and is followed by a general cloudiness. The clearness of the developed collodion picture is much influenced by the condition of all the solutions employed, but particularly so by that of the nitrate bath. If this liquid be in the state termed alkaline it will be impossible to obtain a good picture; and even when neutral, care and avoidance of all disturbing causes will be required to prevent a deposition of silver upon the shadows of the image, especially so when nitrite of silver or acetate of silver are present, both of these salts being more easily reduced than the nitrate of silver. The use of acid is the principal recourse to obviate cloudiness of the image. Acids lessen the facility of reduction of the salts of silver by developing agents, and hence when they are present the metal is deposited more slowly, and only on the parts where the action of the light has so modified the particles of iodide as to favor the decomposition; whereas if acids be absent, or present in insufficient quantity, the equilibrium of the mixture of nitrate of silver and reducing agent which constitutes the developer are so unstable that any rough point or sharp edge is likely to become a centre from which the chemical action, once started, radiates to all parts of the plate. The state of the collodion must be attended to as well as the bath; it should be either acid or neutral, not alkaline. Colorless collodion may be used successfully, as a rule, but sometimes a little free iodine is advantageously added. Care should be taken in introducing organic substances, many of which dissolve out in the bath, and spoil it for giving clear pictures. Glycyrrhizin, however—used to produce intensity—has no effect of that kind and may be employed with safety. The condition of the developing agent is a point of importance in producing clear and distinct pictures. The acetic acid, which is advised, cannot be omitted, or even lessened in quantity, without danger."—*Hardwich.*

Deviation. The angle which a ray, refracted from the surface of any medium and thus deflected from its course, forms with its original direction.

Dew-Point. The temperature at which dew begins to fall. Varies according to circumstances. The temperature of lenses, when in use, must be higher than the dew-point.

Dextrin. A substance of a gummy appearance, into which the interior molecules of starch are converted by diastase or acids. It is named from its turning the plane of polarization to the right hand. Dextrin is rendered soluble by boiling it with a small quantity of dilute sulphuric, hydrochloric, or acetic acid. This is effected at a temperature of nearly a hundred degrees. It is found very good in commerce. It forms a very suitable glue for pasting positive proofs on a sheet. This glue is extremely expeditious, very strong, easy to make at any moment, and does not spoil. To prepare it, it is only necessary to put one or two ounces of dextrine in cold water, in which it is perfectly dissolved. It is also used to divide albumen, and give a little more rapidity to negatives; but it is necessary to be very careful, because an excess would tend to scale the albumen.

Dextrin Dry Process. A process first introduced by M. Dupuis. The collodion is formed of

Sulph. Ether, sp. gr. 60	2 ounces	7 drachms.
Alcohol, sp. gr. 36	1 ounce	3½ "
Gun-Cotton		15 grains.
Iodide of Zinc		15 "

Iodide of ammonium is more rapid, but does not give so good blacks. The sensitive bath is formed of

Fused Nitrate of Silver		150 grains.
Distilled Water	5 ounces	2¼ drachms.
Acetic Acid, No. 8		4 "

Wash, after immersion in the nitrate bath, in distilled water and coat with a solution of dextrin of the consistency of 3° of the syrup measure of chemists. Develop with

Pyrogallic Acid		15 grains.
Distilled Water	10 ounces	5 drachms.
Citric Acid		15 grains.

The picture can be strengthened by adding some drops of nitrate of silver solution.

The manipulations are the same as for other dry processes.

Di-acetate of Lead (Sub-acetate of Lead). This salt is formed when a cold saturated solution of neutral acetate of lead is mixed with one-tenth its volume of liquor of ammonia, and set aside; anhydrous crystalline needles are deposited. A solution of the salt is formed when a solution of the neutral acetate is digested on finely powdered litharge until the undissolved oxide turns white. By evaporation out of contact with air, small crystals may be obtained.

Diactinic. The name given to any substance which permits the actinic rays to pass through it. Substances which permit only non-actinic rays to pass through are called adiactinic.

Dialyze. A chemico-physical process to separate crystallizable bodies from non-crystallizable ones by a membrane, which allows the aqueous solutions of the crystallizable bodies only to pass through; the apparatus for this is called a

Dialyzer. A vessel without top or bottom, having a piece of parchment paper stretched over one end so as to form a kind of dish. Such an apparatus is employed in the preparation of gelatine emulsions. When an emulsion is placed in a dialyzer the crystallizable salts of the emulsion pass through the parchment paper, leaving the colloid gelatine holding the sensitive salts. This process is termed *dialysis*.

Diamond Cement. Dissolve five or six pieces of gum mastic, as large as peas, in the smallest possible quantity of alcohol. Mix this liquid with 2 ounces of a strong solution of isinglass (made by softening and dissolving isinglass in boiling brandy or rum to saturation), having previously incorporated the 2 ounces of isinglass solution with two or three pieces of galbanum or gum ammoniac by trituration. The mixture is to be preserved in a well-stoppered bottle, and is to be gently heated by holding the bottle in hot water at the moment when you are going to use it.

Diaphaneotype. A style of colored photograph invented by Mr. Hawkins, of Cincinnati. The method is to take a paper print —having previously cleaned a glass a very little larger than the print, on which is laid sufficient Canada balsam to cover it and saturate the paper—and lay it face downward upon the glass, rubbing it thoroughly on the back so as to make the paper imbibe the balsam in every part and to avoid air-bubbles, squeezing out all superfluous balsam over the edges of the glass. Set it aside for a few hours and then color on the back with oil colors, and back it up when dry with good stout white Bristol board. The effect is very pleasing and the picture quite permanent.

Diaphanoscope. A dark box in which negatives and positives on glass are examined with a lens.

Diaphragm. A partition or dividing substance, commonly with an opening through it. In photography, a partition of a conical or other shape pierced with a small hole placed between the lenses of the camera tube to concentrate the rays of light and increase the sharpness of the picture. In the Voigtländer camera the diaphragm is placed in front of the lens. (See *Stop.*)

This term is also applied to the brass or gilt border separating the daguerrotype plate from the glass in the case.

A diaphragm, then, is used to reduce, correct, or destroy the spherical aberration in a lens. It is a plate commonly made of metal, perforated in the centre. A B (Fig. 71) is such a diaphragm; *c d*, the aperture of it. If this diaphragm be placed in contact with the lens, it is nearly equal to reducing the lens to the size of the aperture of the diaphragm, and as we have seen elsewhere, the spherical aberration is considerably reduced, but so is the light also. If the loss of light is of little consequence, this mode of reducing spherical aberration may be adopted with advantage. Another way of reducing the spherical aberration is by adopting, for a given aperture and focal length, two or more lenses of the same aperture and the same equivalent focus of the single lens. We have seen before that two lenses of the same aperture, but with focal length as 1 to 2 to each other, the longer one has one-fourth the sperical aberration of the shorter one. Lens M (Fig. 53, page 103) has its focus at *f*. The lenses L and N are of the same aperture as M, but each has twice the focal length of the lens M; therefore each has only one-fourth the spherical aberration of M; but L and N together have the same focal length as M, and as

Fig. 71.

their apertures are alike, the combination L N has only one-half the lateral spherical aberration of the lens M.

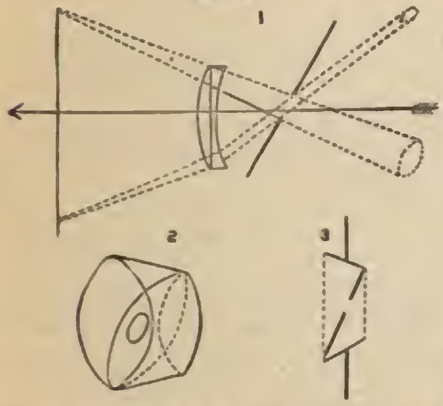
Diaphragm (M. Carey Lea's). This device is for the purpose of obtaining proper exposure for the foreground and distance. The diaphragm may be cut out of soft, dark blotting-paper, and attached to the lens with paste. Of course the slots must cover

FIG. 72.

the lower part of the lens. The bars should not be too wide or too near together. The size should depend upon the diaphragm used. Each bar and each space between two bars should be less than half of the diameter of the stop.

Diaphragm, Conical. A contrivance invented by Joseph Zentmayer intended to

FIG 73.

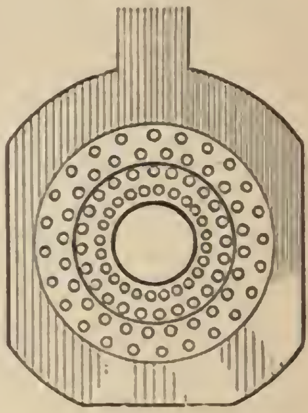


secure the portion of light admitted from the foreground so as to be four times greater than that admitted from the sky, thus keeping back the sky portion of the picture and allowing time for the foreground to impress itself. The same contrivance may be used sidewise when, for example, the view is divided by a diagonal line to produce less contrast in the negative by turning the diaphragm around to an angle of 45 degrees. In the engraving, 1 shows the effect of an inclined stop. Observe the much larger beam that it admits from below than that from above. The engraving is somewhat false. The larger beam should be parallel, to the right of the lens, rather than conical as engraved—or like those of the smaller beam.

In 2 of the figure the conical tube is seen with the inclined plate and the opening of the stop cut in it; 3 is a section of the same when set in place.

Diaphragm for Supplementary Lighting of Plates during Exposure. The device of J. H. Reed. The diaphragm of medium-size opening would represent the one usually

FIG. 74.



used for ordinary work. Into the next larger diaphragm have a piece of perforated tin cut out and soldered in; through this is punched a hole represented by the smaller circle; this gives sharpness, and the perforations give illumination and softness. This plan would almost seem at variance with the laws of light, but can be followed to secure diffusion, illumination, or localization, as the case may be. Cut blanks the size of the

stops adapted to the lens, from sheet zinc blackened, and, after they have been perforated as usual, surround the centre opening with a series of auxiliary perforations of lesser size, as needed. For diffusion or

FIG. 75.

shortness of exposure, a series of perforations, arranged as in *a*, Fig. 75, may be used; for illumination or localization of light, *b* and *c* may be selected. It is apparent that the complementary openings may be arranged at pleasure for the government of lights and shadows.

Diaphragmatic Stereoscope. A stereoscope invented by Signor Volpicelli, of Rome. This instrument is very simple in construction, being without lenses or mirror; it consists of a horizontal rectangular box, the proportions of which are: height, 4½ inches; breadth, 8 inches, and length, 24½ inches. The stereoscopic views are placed against the vertical face of the bottom; two holes are pierced in the anterior vertical face opposite the two centres of the views. Round the two axes, coincident with the vertical faces of the box, two rectangular plates of wood or blackened cardboard turn, of exactly the same height as the images, and about 8 inches in length, serving to intercept the rays proceeding from the two views, which, before arriving at the eye, cross and intersect at a certain point nearly in the centre of the box; and at this spot after a slight effort and giving a proper inclination to the diaphragms, the eyes perceive the images in relief. If after using the relief we turn the diaphragms round on their axes or hinges so that they are supported by the lateral sides of the box and no longer intercept it, continuing at the same time to regard the image in relief, we shall witness a very interesting phenomenon, namely, we shall see simultaneously, besides the image in relief, its two corresponding, or the two views coupled; or we shall see three images at the same time, one at about the middle of the length of the stereoscope which gives an effect of relief, and two at the bottom, and even by an effort of the will, we cannot succeed in seeing two images, those of the projections only. These three images appear without the aid of lenses, mirrors, or diaphragms, because after the diaphragms have served to produce the sensation of apparent relief and they have been turned down, this sensation continues; at the same time it produces the sensation of the two other images. The coexistence of these images is a very singular phenomenon in a physiological point of view, as in a view of that kind the eye receives rays which do not intersect from those which in intersecting constitute the apparent relief, and the eye sees at the same time distinct images of every point from whence these same rays proceed. If the two projectives or stereoscopic views are of complementary colors, the image in relief appears white, as in other stereoscopes, with this additional peculiarity, that after obtaining the sensation of the image in relief and turning down the diaphrams without losing sight of the view, we see three images at the same time, one white in relief and the two others in complementary colors, which are the images of the corresponding projections; this difference of color also adds piquancy to the physiological phenomenon. Those who are not accustomed to the observation of optical phenomena will require some practice when they first attempt to perceive the sensation of relief with this stereoscope. But those whose eyes are of good conformation and who concentrate their attention to the subject, very quickly perceive the object in relief in looking along the middle of the length of the stereoscope. And when they have once succeeded in seeing it, it can be perceived at will without any difficulty.

Diapositive. Transparency; a photograph on glass or other transparent material which, by transmitted light, appears positive. Serves for projections, enlargements, and window transparencies. Such are made either by contact printing or in the camera.

Diastase. A peculiar substance contained in malt which effects the conversion of starch into *dextrin* and grape sugar. It may be obtained from a cold infusion of malt, by adding alcohol, which precipitates it under the form of a tasteless, white powder. In this state it is freely soluble in water.

Diazotype Printing Processes. There are two distinct processes included under this name, both giving colored images upon paper, glass, or fabrics. The diazotype process originated by Messrs. Green and Bevan, in 1889-90, is generally known as the *Primuline* process, inasmuch as primuline—a derivative of benzole, highly sensitive to light—is used as the basis of the process. By this method a positive is produced from a positive, the procedure being as follows: The material (paper or fabric) is immersed in a solution of primuline for five minutes, rinsed with water, and allowed to become almost dry. It is then sensitized by immersion in a solution of nitrate of soda and acetic acid for three minutes, again rinsed in water, and dried in the dark, being now sensitive to actinic light. The material is now placed in a printing-frame under a positive of any kind, and exposed to sunlight for four or five minutes; the progress of printing, which is invisible, being judged by a small strip of sensitive primuline material, exposed alongside the frame and touched with the developing solution from time to time. To develop the print after exposure, it is immersed in different solutions, according to the color desired in the print: for *yellow*, phenol; for *orange*, resorcinol; for *red*, β-naphthol; for *maroon*, naphthol-sulphonic acid; 1 part of the substance used being dissolved in 400 parts of water, made alkaline with caustic potash or soda. If the print is desired to show more than one color, the developers may be stiffened by the addition of starch and applied locally with a stiff brush. When developed, the prints are fixed and made reasonably permanent by washing with water. The yellow tinge over the ground of the print is irremovable. The second diazotype process, invented and patented by Dr. Feer, in 1889, and thence called Feertype, will probably be found to possess wider usefulness in photography than the foregoing. In this process, the image prints out during exposure like a silver print, and gives a positive from a negative. No after-development is required and the ground of the print remains colorless. Printing may be done in sun or electric light. Dr. Feer gives the following summary of the process. Paper or fabric is impregnated with a dilute molecular mixture of a diazosulphonic salt (such as aniline, benzidene) and phenol alkalies (such as phenol, resorcin, and β-naphthol), dried in the dark, and afterward exposed under a negative in the usual way, to sunlight or electric light, for about five minutes. An *insoluble* azo dye is thereupon formed in the illuminated portions of the print, while those parts protected by the densities of the negative from the action of light, retain their original and colorless condition. The picture is thus developed while printing. After exposure, it is simply washed with water or very dilute hydrochloric acid, whereby the unaltered sensitive compound is washed out. The picture is thus fixed, and when dry, is finished. These processes may be utilized for the reproduction of colored transparencies, architects' plans and drawings, and for printing on woollen or cotton fabrics, silks, etc. It is important that the fabrics should be free from dressing size, etc.

Diffused Light. Light which does not impinge directly, but is arrested and diffused by some medium. As the varicolored rays are refracted unequally, the objects appear surrounded with colored edges when viewed through single lenses (chromatic aberration, *q. v.*).

Digesting. Ripening; the stewing of the mixed gelatine emulsion in the warm water-bath for several days, to make it more sensitive. Is rarely done now.

Dilate. To expand; extend; enlarge or extend in all directions; widen; swell.

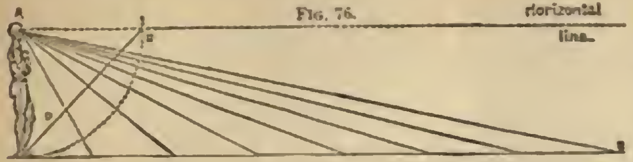
Dilute. To weaken by an admixture of water, which renders the liquid less concentrated.

Dilute Albumen. White of egg, 1 ounce; distilled water, 1 ounce; phosphate or citrate of soda, 2 grains; aqua ammonia, 10 minims. Mix, froth, and filter as usual. A sufficiency of this is to be poured carefully and evenly over the washed sensitized plate as directed in the Taupenot process, and the plate left in a horizontal position for one minute; it is then to be very copiously washed under a tap to remove as much of the albumen as can be got rid of. The more thorough the washing the better. Drain and flood over the plate, as a finish, a small quantity of distilled water; drain thoroughly and dry cleanly. The development is conducted in the same manner and with the same material as for the Taupenot process.

Diminution. As we depart from any object it diminishes in size, apparently. Two

parallel lines seem to approach each other as they recede from the eyes. This is termed diminution and appears to a degree governed by whether the lines commence from a near point or one far removed. All objects diminish in an increased ratio until removed to a

Fig. 76.



certain distance, when the diminution appears less violent. Witness the diagram. A represents the spectator, and the line B a pavement. The circular line which goes through the visual rays as they approach the eye will show the diminished ratio as the objects become more distant; and, as they have to be represented on a plane surface, their proportions will be as a plane surface on D.

Dioptrics. Anaclastics. The doctrine of the refrangibility of rays.

Fig. 77.

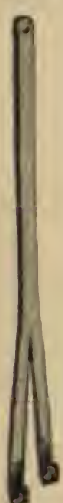


Fig. 78.

Dipper. An instrument made of glass, rubber, wood, or metal, used to lower the glass plate into the sensitizing or other solutions in the various processes of wet-plate photography. (See Fig. 77.)

A form devised by Mr. W. Kenyon is here given (Fig. 78). The parts are all hickory wood, except the centre band, which is a mere brace, and the upper band, which also serves as a brace. To use it, press the upper parts or handle together with the hand; this causes the forks to fly apart, or open, to receive the plate on the rests. As the forks may thus be made to separate more or less, one dipper will answer for several sizes of plates. When the hand releases its pressure, the forks press the plate between them, and there is an end to the dropping of the plate, for it is immovable. In that position it can be dipped, and one dipper should be kept for that work. After exposure, the plate may be placed in another dipper, and thus held when developed and washed, and if you desire, fixed, without moving it. Made as they are of light wood, they are very handy and there is nothing about them to contaminate the bath. A coat of shellac or lard renders them waterproof.

Dipping-Bath Development. Development in an upright bath-dish by means of very dilute pyro developer. The process often takes hours, but produces fully-developed negatives.

Direct. Leading or tending to an end, as by a straight line or course; to pass in a straight line from one body or place to another.

Direct Collodion Positives. These are of two kinds—opaque and transparent. The first such as the ambrotype, the second like the translucent glass stereograms; but the term here applies only to those taken from objects direct in the camera. For the formulæ for taking the first-named style see *Ambrotype* and *Collodion Positive Process.* The second style is used for enlarging by the solar camera, and for stereograms. 1. To take a picture for enlarging purposes, the process for negatives will answer, the only rules to observe being to expose in the camera but a very little longer than necessary for an ambrotype and to develop with a weaker solution, being careful to secure minute details with very little strength in

the shadows. When viewed by transmitted light the shadows should appear thin and translucent; the outlines still sharp and vigorous, but without opacity or blackness. 2. After collodionizing, sensitizing, and exposing the plate as in the ordinary way for negatives, pour on the developer, and as soon as the image appears, wash it off thoroughly, re-dip it into the nitrate bath for three or four minutes, and then finish the development. (See *Stereoscopic Transparencies.*)

Disc. The face or visible projection of a body.

Discoloring. Altering the color or hue; changing the complexion. In photography, removing coloring matter from solutions and rendering them as clear as originally formed.

Discoloring Collodion. Old collodion becomes highly colored by free iodine. This is removed by suspending a small piece of zinc in the liquor and leaving it for several hours.

Discoloring the Albumen Nitrate Solution. (See *Decolorizing Albuminate of Silver.*)

Discoloring the Nitrate Bath. Long use also colors the nitrate bath for collodion plates. The best method for rendering it clear again, is to put the solution into a large bottle and stand it in the sunlight for a day or two, and then filter. A purplish precipitate forms which filters out.

Dishes. Trays. Shallow, square trays of porcelain, glass, wood, ebonite, celluloid, etc., for the different baths. Glass and porcelain dishes are the best, though more expensive. Very convenient are the modern celluloid dishes (tipping dishes), supplied with transparent bottom, and a strip of celluloid of about one-fifth of the length of the tray on one of the narrow sides, forming a space large enough to receive the contained fluid when examining the plate, without taking it out, only tipping the dish.

Dispersion. This signifies, in optics, the division of a ray of heterogeneous light by refraction into its component rays of varying refrangibility.

Dissipate. To scatter; to disperse; to separate into parts and disappear; to waste away; to vanish.

Dissolve. To melt; to liquefy; to convert from a solid or fixed state to a fluid by means of heat or mixture.

Dissolvent. Anything which has the power of melting or converting a solid body into a fluid, or of separating the parts of a fixed body so that they mix with a liquid.

Dissolving View. A projection produced by a double magic-lantern from two pictures, the light circles of which exactly overlap on the screen. Each of the two pictures represents the same object in different form—for instance, a landscape in summer and again in winter. By the use of a "dissolver," the pictures may be made to merge the one into the other.

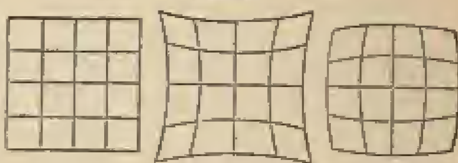
Distance. An interval of space between two objects; the length of the shortest line which intervenes between two things that are separate.

Distillation. An operation by which a liquid is changed into steam, carried off and, by cooling, again made liquid. This is done to purify liquids of foreign matter dissolved in or mixed with them. Water is distilled, ether and alcohol rectified (re-distilled).

Distilled Water. Water evaporated by boiling and again condensed and collected by means of a still. This renders it free and pure from foreign substances and much better for photographic purposes. (See *Still.*)

Distortion. When we describe a network of straight lines and hold a convex lens over it, placing the eye at a distance from it, in the axis of the lens, only two right-angled

FIG. 79.



lines, at the centre, appear true; the others appear curved. When the upper is in the reverse position to the lower one, they appear pin-cushion shape. Distortion of the negative lens is reversed, the lines appearing as the curved sides of a barrel.

Dithionate. A compound formed by the union of dithionic acid and a base.

Dithionic Acid. Dithionic or hyposulphuric acid is formed by the combination of two atoms of sulphur with five atoms of oxygen, and is usually developed in the toning bath by use.

Diverge. The opposite to converge. To tend from one point and recede from each other; to shoot, extend, or proceed from a point in different directions. Rays of

light proceed from the sun and continually diverge.

Divisibility. The quality of being divisible; the property of bodies by which their parts, or component particles, are capable of separation.

Divisible. Capable of division; that may be separated or disunited.

Dormant. At rest; not in action.

Double Dark-Slide. A slide or plate-holder which can contain two plates, so that two negatives can be made, independently, by turning the holder, after the first exposure, for the second plate.

Double Decomposition. When two acids of mixed substances change bases, or two bases change their acids, each having a greater predilection for the other acid than it has for its own, or *vice versa*, the change which takes place is termed, in chemistry, double decomposition. This action may be better understood by the following diagram. Thus, solutions of sulphate of zinc and acetate of lead are mixed:

	Composition.		Composition.	
Sulphate of zinc.	Sulphuric acid.	╲ ╱	Acetic acid.	Acetate of lead.
	Oxide of zinc.	╱ ╲	Oxide of lead.	

Double Iodide. A solution of iodide of silver made in the following manner: To 4 ounces of distilled water add 40 grains of nitrate of silver, and shake until the nitrate is dissolved; then add 32 grains of iodide of potassium, and shake well as before. On the addition of the iodide the solution will become turbid and yellow. When the crystals are all dissolved allow the precipitate to settle, and then carefully pour off as much of the fluid as possible. This precipitate is yellow iodide of silver and is quite soluble in water. Wash it twice in warm distilled water. This is now to be dissolved, by first adding ½ ounce of distilled water and then 400 grains of iodide of potassium, and shaking, which will leave the solution perfectly clear. Now add distilled water, a few drops at a time. Upon the addition of the water the surface of the solution will become turbid, but will clear up again on being shaken. Repeat this addition of the water until the solution will no longer clear itself, and then add a crystal or two of iodide of potassium, in order to restore its perfect transparency. In this state an exact balance will have been struck between the water and the iodide, and it only remains to filter the solution which will then be ready for use.

Double Lens. An objective consisting of two combinations, between which the diaphragm may be placed. It differs from a single combination in being free from spherical aberration, enabling it to work with a comparatively larger opening (with shorter exposure). These are divided into symmetrical and non-symmetrical double objectives, as the two combinations are symmetrical or otherwise to the diaphragm between them. To the first (symmetrical) group belong, among others, the Steinheil aplanat, Voigtländer's euryscope, Dallmeyer's rectilinear, Busch's pantoscope; to the second (unsymmetrical) group, Steinheil's antiplanat, Zeiss' anastigmats and apochromat, and Dallmeyer's triplet.

Double Periscopic Lens. A photographic objective, invented by Mr. J. T. Goddard, of England, who thus describes it: "A deep *non*-achromatic meniscus, with a compound of an equally double-concave flint (worked to radii equal to the concave radius of the meniscus), and cemented to a crown of nearly equal focus to the flint; these three lenses, with the concave sides together, form a compound that may be termed 60° or 70°, without the image moving much from the centre of the shadow. The color is corrected by the cemented compound being much over-corrected, so as to balance the single meniscus. This compound may be used either side toward the radiant, only the stop must be on the side nearest to the cemented lens."

Double-Pose Photograph. A photograph in which one and the same person is represented twice. Such pictures are made in the usual camera by means of an arrangement by which the objective or else the plate-holder can be, in part, covered. The person assumes a different position for the second exposure, during which that part of the plate already exposed remains protected from the light. Also called "freak" photographs.

Double Printing. Printing one positive proof from two or more negatives. For instance, if a finely drawn figure of a lady standing is wanted, it cannot be obtained in one negative, if the head looks over the shoulders a little, without having a badly formed neck; therefore, one negative of the

body, carefully arranged according to the end in view, and another of the head and neck are made, and by double printing one portrait is made of the two; thus proportion and elegance are obtained. To do this, print a proof that is to act as a mask. Cut the figure carefully out; then you will have two pieces, one the background and one the figure of the picture. Place the negative in the press. Put the background carefully in its place, upon which put the sensitive sheet, and print. Then put the print in the usual "background press" with the figure portion placed so as to carefully protect the printed portion from the light. Then do what you please with the background portion; either light it into a nice gray or put a negative of stippled background upon it and print at pleasure. Applied in many ways to landscape and group printing. (See *Combination Printing.*)

Doublet. An objective, constructed by Ross, consisting of two achromatic lenses, each of which may be used as a single landscape lens. The combination gives pictures which even with stop $\frac{1}{15}$ are free from distortion. (See *Anastigmat* and *Double Objective.*)

Double Transfer Process. A sort of carbon process, consisting in transferring the pigment picture first from its paper support upon some other, and from this to a final support. Such pictures are not reversed, as in single transfers, even when common (not reversed) negatives are used.

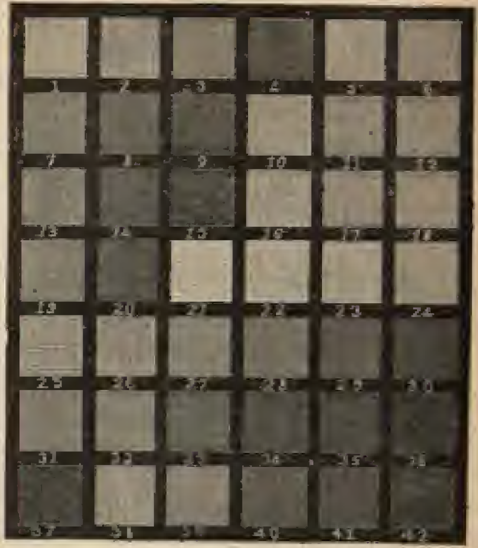
Drachm. English weight=3.888 grammes.

Draffin's Dry Collodion Process. A modification of Taupenot's Collodio-albumen Process. The plate of glass, after cleaning, is warmed, coated with collodion, and sensitized in a positive bath, in the usual way; it is then placed in a dish, face downward, and washed gently for two or three minutes, and stood up on one corner to drain.

Drapery. Dress of the subject, also the surrounding accessories.

Drapery Chart. The original consisted of pieces of woollen drapery of varied colors and shades, arranged as numbered and photographed under a good light, for the guidance of photographers in determining the effect of light upon the dresses of their patrons. The arrangement is suggestive to those wishing to contrive some such guide for their own practice. It was devised by Mr. George B. Ayres. (See Fig. 80.)

FIG. 80.



Dropping Bottle. A small bottle with ground-in stopple, which has two gutters and when turned down accommodates itself or corresponds with two openings in the neck of the bottle, from one of which, supplied with a tube, the liquid can be made to drop.

FIG. 81.

FIG. 82.

Drop Shutter. Hundreds of contrivances have been offered for the instantaneous ex-

posure of the sensitive plate. The diagram represents a form in common use. (Fig. 82.)

The simplest and oldest form of exposure shutter, placed either before or behind the lens, consists of an apparatus with a loose piece which, when released from its place, falls vertically across the lens. This loose piece has an aperture similar to the working aperture of the lens, and as this aperture crosses the lens in its descent the exposure is made. The action is generally controlled by an elastic spring, upon the strength of which the velocity or speed of the shutter depends.

Draw a Proof. Applied to the action of light upon photographic paper or plate, in the production of the picture.

Dry Albumenized Collodion. A term applied to collodio-albumenized plates. (See *Collodio-Albumen.*)

Dry Collodion. A collodion the peculiar properties of which are its capability of retaining its sensitiveness to the light for a long time after having been dried upon the plate, and requiring no preservative solution. There are several formulas for making this collodion. For instance:

1. A.	Amber	620 grains.
	Chloroform	5 ounces.
	Ether	5 "

Filter.

B.	Ether	7 ounces.
	Alcohol	3 "
	Gun-cotton	98 grains.
	Iodide of Ammonium	62 "

Add solution A and filter.

2.	Alcohol	3 ounces.
	Ether	1 ounce.
	Pyroxylin	4 grains.

The pyroxylin must be made at the maximum of temperature.

Dry Collodion Process. With either of the collodions noted in the last article observe the following manipulations: Coat the plate as usual; excite in a 35-grain bath having a slight trace of acetate of silver; remove the free nitrate by plunging the plate in a vertical bath of water (not by pouring); let the plate drain, and then put it away until required for use. Do not dry it by artificial heat. Before developing tack the edges of the film down with spirit varnish, put on with a camel's-hair pencil. It must be allowed to get dry; then immerse the plate in a dish of water for five minutes, which done pour over it the pyrogallic developing solution to which a drop or two of fresh solution of nitrate of silver has been added, and substituting citric for acetic acid. The picture comes out slowly, but ultimately assumes any desired intensity. Fix and dry as usual. The films of dry collodions are extremely tender and are so apt to tear and wash off that the only safety is to tack the edges as directed, and to wash by immersion in vertical baths.

Dry Developer. This is a dry developing powder suitable for the travelling photographer. Mix gallic acid, 3 grains; pyrogallic acid, 1 grain; citric acid, 1 grain. Make as many packets as may be thought necessary, and dissolve one in an ounce of water when required.

Dry Iodine. (See *Iodine.*)

Dry Plates. The name given to glass plates coated with a film of gelatine in which a sensitive salt of silver has been emulsified, *i. e.*, is held in suspension. Dry plates are now almost exclusively used in all photographic processes, except photo-mechanical and a few other special branches of work. They may be obtained commercially of such excellence, uniformity, and at such a cheap price that it would be folly on the part of a photographer save for experimental purposes to prepare his own. Formulæ for the preparation of dry-plate emulsions may be found under *Emulsions.* In choosing dry plates for photographic work care should be exercised to select those properly adapted to the work in view. For landscapes, interiors, and outdoor work without figures, slow, thickly-coated plates rich in silver are preferable. For landscapes with figures, street views, and animated subjects more rapid plates are desirable; while for portraiture and instantaneous work of all kinds the most rapid plates obtainable give the best results.

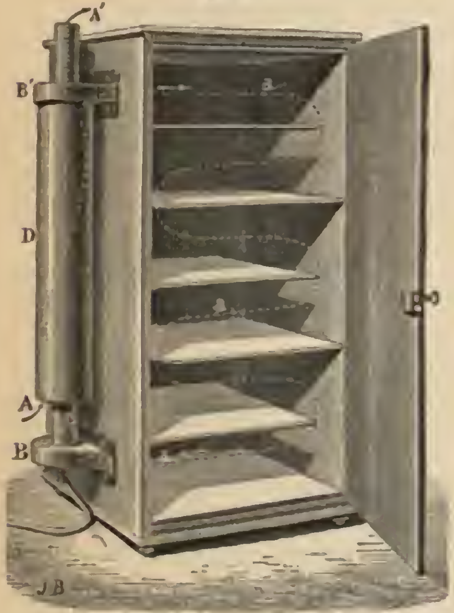
Dry Process. The process or processes for taking negative photographs on glass with one or more prepared films in a dry state with or without preservative mixtures. These processes are so numerous that they must be given under the names of their inventors. (See also the *Oxymel Process; Collodio-Albumen Process*, etc.)

Dry Process—Instantaneous. Dr. Henry Draper, of New York, some years ago communicated to the American Photographical Society an improvement in Major Russell's

modified tannin process by which instantaneous negatives are obtained upon dry plates. It consists essentially in keeping the plate at a high temperature during development, the pyrogallic and silver being poured on cold. The plates are prepared in the way recommended by Major Russell (see *Russell's Tannin Process*). After exposure in the camera they are heated in hot water. The ordinary developer, which has not been warmed, is floated on as soon as the plate comes out of the water, and worked in the usual manner. If the plate cools sensibly before the picture is dark enough, dip it again in hot water and continue the development.

Dryer for Phototype Plates. A burner, c, furnishes a current of hot air which fol-

FIG. 83.



lows the direction indicated by the arrows. The air in the jacket A D B, which surrounds the tube c A′, is heated by the combustion of the burner, c; it enters from above into the dryer, a a, by an opening made in the side B and A; hence it passes in descending over all the horizontal separations, which are bunched in such a manner as to receive in all their length a current of hot air. Having reached the bottom it makes its exit by an opening leading directly into the tube at c, and by increasing the current materially aids the combustion. The exterior air enters the bottom of the jacket by a small opening at A. The closet of the dryer is furnished at the bottom with adjusting screws in order to permit the leveling of the interior separations at one operation.

Drying Agents or Desiccators. The name given to any agent which will absorb moisture from any substance, gas or liquid. Used to prepare such substances for accurate weighing or drying, for laboratory purposes. Potassium carbonate, quicklime, phosphoric anhydride, most fine powders, and fibrous materials are so used. For preserving sensitive papers from moisture, calcium chloride is generally used, as in the platinotype process.

Drying Apparatus. It consists of a common flour barrel with a sheet-iron bottom, top open. A lid should be provided two or three inches larger than the top of the barrel. To the under lid a frame is attached almost as long as the barrel. To this fasten the paper and let it down into the barrel to dry. Tack thick cloth around the under side of the cover to keep the heat in the barrel by packing the joint. Heat may be supplied by an alcohol lamp, as shown.

FIG. 84.

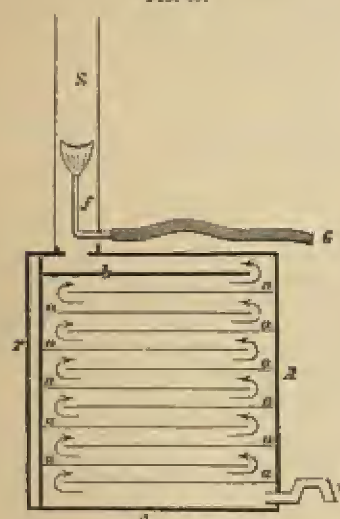
Drying-Box for Drying Phototype Plates. It is made of sheet iron and is supplied with a gas tube extending the whole length of the upper portion of the box. The front should be open at two-thirds of its height and a wire cloth separate the upper third portion from the other two. The front is provided with hinges in order to light the burners. The plates are placed for drying, after varnishing, in the lower open portion, resting on the bottom. The wire cloth is used to prevent the alcohol from taking fire.

Drying-Box. A box for drying prepared plates for the *dry processes*. The box is

made of double tin three-eighths of an inch all round, and also a partition of the same in the middle. This tin box is enclosed in a mahogany one, in order to keep in all the heat. The tin is made to project about half an inch above the box to allow for the cover to shut down light-tight. In a suitable corner on the top of this tin box put a hole as large as possible, with a screw to fit into it. Through this hole hot water is poured in. At the bottom corner of the box, on the side, put another hole with a small pipe fitted into it, projecting about half an inch beyond the wooden box, also fitted with a screw, which is for emptying the box when the water becomes cold. On the sides of the box are placed small pieces of tin, top and bottom, about one inch long and projecting just enough to slide the plate on. Of course, these pieces of tin must be put at an angle, as the plate will have to stand so for draining.

Drying-Box for Emulsion Plates. It is made of tin. *T* is a door locked tight. *a a* are shelves of tin so arranged that the air

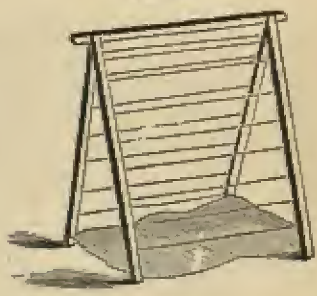
FIG. 85.



circulates in the direction shown by the arrows. After the plates are firmly set they are rested upon these shelves. The air enters at *u*, and the chimney *S* creates the draught. The gas-flame *f* burns inside the chimney, *G* being the supply-pipe. The drying may be hastened in damp weather by a pan of fused chloride of calcium set at the bottom of the box. The piece *b* should be painted with dead black, as well as the lower surface of the upper wall of the box. The door *T* must fit tightly to the edges *a a*, otherwise there will be no circulation of air. A layer of felt is fitted under the door.

Drying-Frame for Prints. When the prints are removed from the washing tanks they are hung to dry on lines arranged as shown in the figure. Instead of hanging lines across the room to the permanent annoyance of all passing to and fro, this double, square, light framework will be found better. It is hinged at the top, spread

FIG. 86.

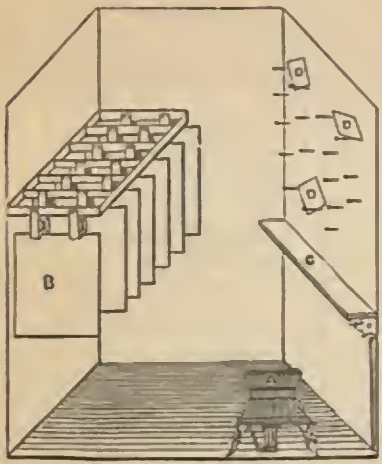


out at the base, and there connected by canvas, making a triangle-shape at the ends; and across the frame the lines are hung at proper distances apart, and on these lines are hung the prints to dry. It will be seen by the illustration annexed that the canvas serves to catch the drops, thus keeping the floor clean. It also keeps the frames from spreading out too far. When not in use the frames are closed together and placed on one side out of the way.

Drying-Room. After the sheets of paper are sensitized they must be thoroughly dried. This may be done in a box, closet, or room, according to the extent of the operations. For establishments where these are large the diagram represesents a good system. A (Fig. 87) is a gas stove for heating the room, B is the paper as fastened to the clips for drying; C is a shelf on which the silver-bath bottles as well as the collodio-chloride

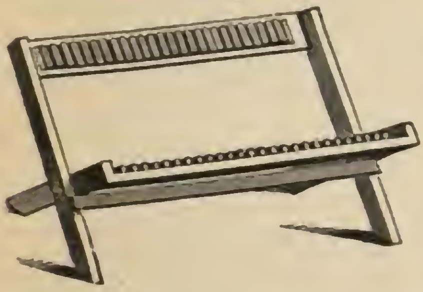
bottles are placed; D D D are plates, each resting upon two nails.

Fig. 87.



Drying-Rack. A simple contrivance in general use for drying and draining plates

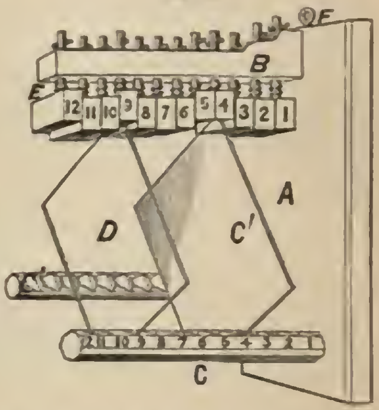
Fig. 88.



or negatives. Made to fold, of pieces of wood supplied with strips of corrugated iron, or of wood notched. (See Fig. 88.)

Drying-Stand for Gelatine Plates. Designed by Leon Vidal. As soon as the plate is covered place it on a perfectly levelled sheet of plate glass, which is kept cold by a stream of cold water running under it. As soon as the gelatine emulsion has set take it up and insert it into the rack. This rack or plate-stand is easily made. *A* is a piece of wood into which is glued the support, *B*, and the two legs, *C C′*. The support, *B*, holds one dozen pegs, which slide up and down with ease. A spring, *E*, is put on each peg, in order to keep it down. On the two legs, *C C*, are twelve notches corresponding to the twelve pegs. The apparatus is hung up against the wall of the drying-room by means of the hook, *F*. As soon as the film of gelatine has set the plate

Fig. 89.



is taken, and one of its corners is inserted into a hole at the bottom of peg No. 1. A little force is used to push up the spring, and the plate is then put into the notches; the spring now pushes down the peg, and the plate is firmly held. The same movement is repeated for the twelve plates, and the rack is hung up for them to dry, which is easy, as there is the space of an inch between the plates.

Dusting-in Process (Powder Process). A method by which a thin film of gum, sugar, and bichromate, after exposure under a negative, is dusted-in with graphite powder, which adheres to those parts only protected from the light during exposure, thus forming a duplicate negative. Used in making duplicate negatives for burnt-in photographs and prints on wood for woodcuts.

Dyes as Sensitizers. It has long been known that by the addition of dyes to the emulsion with which the gelatino-bromide plate is coated, greater sensitiveness to certain colors could be obtained than is possible with ordinary plates. The substances most commonly used are the eosin compounds, such as the dyes erythrosin, rose

bengal, eosin, chinolin, etc. These may be applied in solution to the ordinary plate before exposure, or added to the emulsion before the plate is coated. (See *Orthochromatism.*)

Dynactinometer. An instrument for measuring the intensity of the actinic rays and comparing the powers of object glasses. Invented by Mr. Claudet, of London.

E.

Ebonite. Hardened rubber, capable of being polished; black, horny substance, used in place of gutta-percha, for bath dishes and trays.

Eburneum Process. A method of transferring a chloride of silver collodion print, on a plain collodion support, to an imitation ivory plate (oxide of zinc in gelatine).

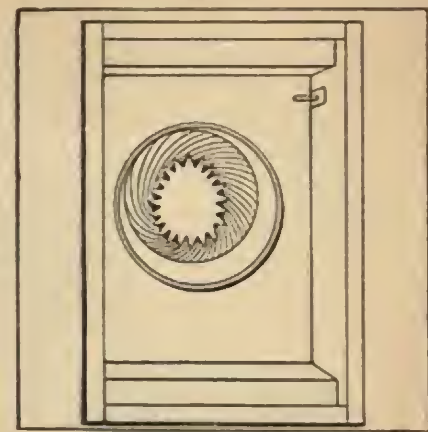
Ectograph. A glass transparent positive photograph, backed up by virgin wax, and colored on the back. The invention of Prof. C. A. Seely.

Effervescence. A kind of natural ebullition; that commotion of a fluid which takes place when some part of the mass flies off in a gaseous form, producing innumerable small bubbles.

Efflorescence. The formation of a mealy powder on the surface of bodies; also, the formation of minute spicular crystals, sometimes called *flowers*, or saline vegetation, in consequence either of the abstraction of the combined water by the air, or by the absorption of oxygen and the formation of a saline compound. Efflorescence sometimes takes place on the collodion film in drying after fixing, when the temperature of the room in which the plate is stood up to dry is lower than when the plate was coated, sensitized, exposed, and developed. A very beautiful print of an efflorescent surface may be made from a plate coated, silvered, and exposed to the light for a second or two, then developed, fixed, and stood up to dry, when a stream of cold air can fall upon it.

Egyptian Photograph. A style of picture vignetted with a black background. A dark background of velvet is best, in connection with Hyatt's vignetter, as shown in Fig. 90. The outside of the background is black and the lighter ground used secures light enough about the head to give it rotundity and proper effect.

Fig. 90.



Eikonogen. $C_{10}H_5\left\{\begin{matrix}NaSO_3\\HO\\NH_2\end{matrix}\right.$. The sodium salt of amido β-naphthol β-sulphonic acid, first described by Meldola in 1881, patented as a developing agent by Andresen, in 1889. Eikonogen comes in small, whitish-gray crystals, sparingly soluble in water, about eighteen grains to the ounce of water. It is non-poisonous and does not stain the fingers. In practice, eikonogen is more energetic as a developer than pyro or hydroquinone, its reducing action being similar to ferrous oxalate, giving a clear negative of a blue-black color. It is especially recommended for the development of instantaneous and snap-shot exposures, and may be used repeatedly. Negatives developed with eikonogen incline to softness with abundance of detail. Its use is also advised for transparencies, lantern-slides, and bromide papers. In the preparation of eikonogen developer, distilled water should be used, and should be boiled a few minutes, the ingredients being added while it is hot, and the eikonogen last. The drawbacks to the use of eikonogen are its liability to fog the plate, and its excessive rapidity of action in cases of over-exposure. Eikonogen in solution may be preserved by the addition of acid sulphite of soda; it should be kept in bottles always full, and

carefully stoppered to prevent oxidation. To prepare eikonogen developer, mix

A. Sodium Sulphite (cryst.)	30 parts.	
Eikonogen (cryst.)	16	"
Citric Acid	3	"
Potass. Bromide	2	"
Water	480	"
B. Sodium Sulphite (cryst.)	100 parts.	
Potass. Carbonate (C. P.)	120	"
Water	480	"

For normal exposures use

Of A	4 volumes.
Of B	1 volume.
Water	3 volumes.

Another good formula is

Eikonogen	125 grains.
Acid Sulphite of Sodium	½ ounce.
Distilled Water to make	25 ounces.

For accelerators, use ether caustic or carbonated alkalies. An important point in development with eikonogen is the temperature of the solutions; the best results are secured at 65° F. If additional intensity is desirable, use as required a portion of the following pyro solution:

Sodium Bisulphite	1 part.
Pyrogallol	2 parts.
Water	3 "

When using eikonogen the acid fixing bath is advised, as obviating stains and hardening the film, besides preventing frilling and blistering.

Electric Light. The most splendid artificial light known.

Electric-Light Photography. The application of electric light in photography is now quite common. The engraving here given represents one of the methods used in the skylight for directing this light and is self-explanatory. There are many inventions of this kind, with more or less merit, according to the ease and certainty by which the light may be directed upon the subject. (See Fig. 91.)

Electric Spots. Streaks or markings proceeding from the corners of a collodionized plate, ascertained to be due to voltaic electricity generated by the corners of the dark slide. They occur only when the corners are made of silver wire.

Electro-Chemistry. That science which treats of the agency of electricity and galvanism in effecting chemical changes.

Electrode. A name applied to what is called the *pole* of the voltaic circle. The electrodes are the surfaces of air, water, metal, etc., which serve to convey an electric current into and from the liquid to be decomposed.

FIG. 91

Electro-Etching. A method of etching, by means of electricity, the image on the daguerrean plate.

Electrography. A process for discoloring photographic paper by means of electricity, discovered by M. Pinaud. The principle consists in multiplying the number of sparks, from an electric battery, which impinge upon the surface of the photographic paper, following the form of a design, in order to multiply the number of spots which are produced. For example: on the surface of a spotted plate place a sheet of *dry* paper prepared with bromo-iodide of silver, and retain it by means of a glass plate. Then pass the discharge of a powerful Leyden jar along the metallic ribbon; each solution of continuity is worked by a spark, and spots are formed on the paper at all the corre-

sponding points. A very exact representation of the design which is traced upon the plate is thus obtained.

Electro-Photography. The production of photographs by means of electricity, or electric light. This branch of photography may be divided into two parts: 1. *Accelerating the time of exposure of the daguerrotype plate in the camera by means of the galvanic current applied directly to the plate.* 2. *Making a negative or positive in the camera, or printing a proof from a negative, by the rays from an electric light.*

Electro-Phototypy. A name given to Sutton's process for producing half-tone printing blocks. (See *Sutton's Process.*)

Electro-Silver Plating. The art of covering a metallic plate with a surface of silver by means of the galvanic battery. In order to insure a perfectly pure surface of silver, many operators deposit a thin film of silver on the daguerrotype plate by the galvanic battery. This is a good plan, and well repays the additional trouble, by the superior brilliancy of the proofs obtained. The apparatus necessary is a galvanic battery and a solution jar of suitable size and shape. The solution jar is filled with a solution made of

Cyanide of Potassium	2 ounces.
Oxide of Silver	¼ ounce.
Water	1 pint.

As soon as the cyanide and oxide are dissolved the liquid is ready for use. A piece of silver, larger than the daguerrotype plate, should be placed in the solution jar, and connected, by means of a wire with the negative (zinc) pole of the battery; another wire, with a clip at one end to hold the daguerrotype plate, is attached to the positive (*copper* or *platinum*) pole. The plate to be silvered should be carefully cleaned and polished, and, when attached to the clip, plunged into the silver solution opposite to the silver foil, and suffered to remain until the desired quantity of silver is deposited upon it; it should then be taken out, washed with clean water, and cleaned and polished as before. Mr. Davie gives the following as the best method of preparing the silvering solution. If you wish to prepare 2 gallons of solution: saturate 1 pint of pure water with cyanide of potassium, until there is an excess of potassium in the bottom of the bottle; then add to the solution of cyanide as much oxide of silver as it will take up, which will not be less than two ounces, thus giving a saturated solution of cyanide of silver, and on every occasion, when this solution is made, whether much or little, it should be made in the same manner. Fill the solution jar nearly full of pure soft water and add sufficient cyanide of silver to coat the plate in one minute. This solution requires no filtering; but it should be stirred with a glass rod every morning before use. The plate should be well cleaned and buffed, and immersed in pure soft water before it is placed in the silvering solution.

Electrotypy. In photography, the reproduction of daguerrotype or other metal proofs by the electrotype process. A Bunsen cell and a glass solution jar are all the apparatus necessary for the purpose. The plate must be deprived entirely of hyposulphite of soda and gilded; its back is then covered with a coating of wax or varnish composed of 1 part turpentine and 2 of wax. Care must be taken that this coating of varnish, which should be applied hot, does not interfere between the plate and the connecting wire of the precipitation trough. The sulphate of copper, into which the plate is plunged, must be dissolved in cold water and carefully filtered. Put the positive electrode (a copper plate, which dissolves in the jar) in connection with the negative pole of the battery (carbon) and immerse it in the bath; establish also a connection between the proof to be reproduced and the other (zinc) pole, and when firmly attached by means of binding screws, it must be immersed in the bath, when it will immediately become covered with copper.

Electro-Zincography. The art of engraving on zinc by means of the galvanic battery. The design is drawn upon the zinc plate with a lithographic pencil. A preparation of gall-nuts and gum-arabic, such as is employed in lithography, is put over the plate and a mixture of bitumen of Judæa and Burgundy pitch is sprinkled over this. Then remove the excess and gently heat the back of the plate in order to melt the powder which mixes with the lithographic ink and thus forms a varnish. The plate is then bitten in by means of the galvanic battery. (See *Photo-Zincography.*)

Elementary Bodies. Elementary bodies embrace all those substances which cannot, in the present state of our knowledge, be

resolved into simpler forms of matter. They are divided into metallic and non-metallic, according to the possession of certain general characters.

The elements are thus foundation bodies or substances out of which composite bodies are formed and into which these can again be disintegrated. Sixty-seven elements are now known, classified as non-metals, light metals, and heavy metals.

Elementary Colored Rays. A ray of light, besides its heat-producing and chemical rays, possesses a luminous power derived from a combination of various colored rays. This combined ray can be decomposed by the prism, and each color separately exhibited. These single rays are termed "elementary colored rays." (See *Light*.)

Elemi. A resin; the product of a tree in Ceylon; it is of a pale-yellow color, exteriorly brittle, but soft and tough within; having a warm bitter taste, and a fragrant, aromatic smell, partaking of fennel. It is only partially transparent, even in thin plates; is very fusible, and has a density a little greater than that of water.

Elimination. Removal, as by washing; for instance, hyposulphite of soda from paper pictures.

Eliminators, Hypo. Many substances have been proposed at various times to remove all traces of hypo soda from prints and negatives with a view to rendering them thereby more permanent. Chlorine in solution; eau de Javelle (potassium hypochlorite); sodium hypochlorite; Flandreau's eliminator (zinc hypochlorite), and other substances have been advised in this connection. Hydrogen peroxide is also said to be a good hypo-eliminator when used freshly prepared. All these substances, however, are unstable in themselves, and sometimes produce reactions as dangerous as hypo soda. The best hypo-eliminator is water, and thorough washing will insure the permanency of negatives or prints more effectually than any other means.

Emery. Emery powder, gray to black powder of great hardness. Used for grinding and polishing metals and glass. Emery paper is made by coating paper with glue and sifting the powder over it.

Emulsions. As understood in photography an emulsion is a viscous fluid, such as collodion or gelatine, in which a sensitive silver salt is held in suspension. Glass plates coated with emulsions are used in negative and transparency making, and papers coated with bromide or chloride emulsions are used in various printing processes. Only a few of the standard emulsion formulæ can be given here; those who desire to look thoroughly into the subject are referred to Wilson's *Quarter Century in Photography*, Eder's *Handbook of Emulsion Photography*, Abney's *Photography with Emulsions*, Eder's *Modern Dry Plates*, Pringle's *Processes of Pure Photography*, and Woodbury's *Aristotype*, which constitute a fairly complete literature of emulsion photography. Emulsion photography may be divided into two classes: first, printing-out emulsions, in which an excess of silver nitrate is present, and on which the image may be printed out; and second, those emulsions in which no free nitrate of silver is present, and which require development to produce the image.

Collodio-Chloride Print-out Emulsion:

a. Alcohol	1	ounce.
Ether	1	"
Pyroxylin	12	grains.
b. Silver Nitrate	60	"
Water	1	drachm.
c. Strontium Chloride	64	grains.
Alcohol	2	ounces.
d. Citric Acid	64	grains.
Alcohol	2	ounces.

Mix 30 minims *b* with *a*, add a drachm of *c* and half a drachm of *d*. Shake well and coat the desired surface, paper or plates, at once.

Gelatino-Chloride Print-out Emulsion:

a. Gelatine	35	parts.
Distilled Water	500	"
b. Silver Nitrate	7	"
Distilled Water	30	"
c. Strontium Chloride	1½	"
Distilled Water	25	"
d. Citric Acid	3½	"
Distilled Water	25	"

Heat *a* in a water bath, then add *b*, then *c*, and finally, after well shaking, add *d* and liq. ammoniæ (0.880), 50 drops.

Gelatino-Chloride Emulsion for Transparencies:

a. Sodium Chloride	80	grains.
Nelson's No. 1 Gelatine	30	"
Hydrochloric Acid	5	minims.
Water	1¼	ounces.
b. Silver Nitrate	200	grains.
Water	½	ounce.
c. Nelson's No. 1 Gelatine	30	grains.
Water	1	ounce.

Mix *b* and *c*, heat to 60° C., and emulsify *a* into the mixture. When emulsified pour over 240 grains Nelson's emulsion gelatine swelled and dissolved in 2 ounces of water; mix well, let set, and wash.

Gelatino-Bromide Emulsion for Plates:

a.	Silver Nitrate	200 grains.
	Water	4 ounces.
	Perchloric Acid	5 drops.
b.	Potassium Bromide	170 grains.
	Potassium Iodide	10 "
	Nelson's Emulsion Gelatine	40 "
	Water	6 ounces.

Add liq. ammoniæ to *a* until the solution is just clear. Heat *b* to 60° C., and emulsify *a* into it. Heat again until blue, let cool, pour over 200 grains dry gelatine, remelt, let set, and wash.

Gelatino-Bromide Emulsion for Bromide Paper:

a.	Silver Nitrate	17 grains.
	Citric Acid	100 "
	Water	3 ounces.
b.	Sodium Chloride	17 grains.
	Potassium Bromide	40 "
	Citric Acid	100 "
	Nelson's No. 1 Gelatine	40 "
	Water	3 ounces.

Emulsify *b* into *a*, let cool, pour over 200 grains Nelson's emulsion gelatine, previously swelled in water; melt, let cool, and wash, when it is ready for coating the paper.

Leaper's Emulsion for Watch-Dial Portraits:

a.	Alcohol	1 ounce.
	Ether	1 "
	Pyroxylin	12 grains.
b.	Silver Nitrate	60 "
	Water	1 drachm.
c.	Strontium Nitrate	64 grains.
	Alcohol	2 ounces.
d.	Citric Acid	64 grains.
	Alcohol	2 ounces.

Mix thirty minims *b* with the whole of *a*, add a drachm of *c* and half a drachm of *d*. Shake well after each addition, and coat at once.

As both gelatino- and collodio-chloride and gelatino-bromide plates, opals, and papers can be obtained commercially, of excellent quality, the reader will generally find it to his advantage to use the commercial article in preference to preparing his own plates or paper. The preparation of emulsions and their coating on plates or paper requires much skill and experience, upon which their uniformity and consequently the results depend. The above formulæ will suffice to show the worker the nature of the materials he has to work with.

Emulsion Tube. Used for breaking up the emulsion of bromo-gelatine for dry plates. (Fig. 92.)

FIG. 92.

Enamel. A substance of the nature of glass, differing from it by a greater degree of fusibility and opacity. The basis of enamels is a highly transparent and fusible glass, which readily receives a color on the addition of metallic oxides. The base or flux for enamels is made of red lead 16 parts, calcined borax 3 parts, powdered flint glass 12 parts, powdered flint 4 parts; fused in a Hessian crucible for twelve hours, then pour it out into water and reduce it to a powder in a mortar. To give this the desired color see any work on Enamels.

Enamel Color. Developing powder. Finely powdered glass or porcelain colors of different tones, usually consisting of fusible metal oxides, mixed with a flux; used in the dusting-in process for pictures which are to be burned in on porcelain, fayence, etc.

Enamelling. Giving a high gloss to albumen prints by first floating them on a hot gelatine solution and then squeegeeing them on a glass plate coated with plain collodion and stripping off when dry.

Enamelling Silver Prints. Now that glossy-surfaced collodion and gelatino-chloride papers are so commonly used in photographic printing, there is little demand for enamelled silver prints. To enamel a print proceed as follows: Thoroughly clean a piece of plate glass larger than the print to be enamelled, dust over with talc or French chalk, and then run a thin film of albumen round the edges of the plate. Now coat the plate with plain collodion, and prepare in a water bath a 10-grain gelatine solution. Immerse the collodionized plate and print into the gelatine solution, avoiding air-bubbles; bring the face of the print in contact with the collodionized surface, remove from the bath, and squeegee into optical contact. When thoroughly dry the print may be stripped from its glass support with a knife; then the collodion film will be found to adhere to

it, giving it an extremely brilliant surface. To enamel prints without the use of collodion or gelatine proceed as follows:

Mix ox-gall and alcohol in equal parts and let the solution stand three days, when it should be filtered and kept for use.

Coat a glass plate with this solution and lay the print upon it in close contact. Let it dry—which requires about one hour—and paste a sheet of paper on the back of the print, this sheet of paper being afterward coated with a mixture of gum, dextrin, and a little glycerine. The whole being dry, remove it from the plate, and it will now suffice to apply it with strong pressure on a mount previously wetted, to have the print mounted with a full gloss.

Enamels. (See *Ceramic Photography.*)

Encaustic. The method of painting-in heated or burnt wax.

Encaustic Paste. A compound invented by M. Clausel for varnishing photographic prints. It is composed of Ceylon elemi dissolved in the best oil of lavender; the addition of some oil of cloves completes the mixture. The proportions are not easily given; they are such as to yield a consistency resembling that of a firm pomade, which can yet easily be spread upon a paper surface by means of the fingers. It must be as firm as the manipulation during its use admits of. To apply it the proof must be mounted on cardboard. When dry and tense take the encaustic upon the finger and spread it equally, so as just to cover the paper, and leave it to set for five or ten minutes, according to the temperature; then rub the surface with a folded-up pad of woollen cloth (merino answers best); leave it for a short time to further set or harden and again rub it. Finally, in a few moments, when more hardened, finish the polishing with a fresh piece of merino, moved briskly in order to get a uniform gloss. A little extra pressure will remove any smears arising from the presence of an excess of paste. This has been found a great protection against fading.

Energia. A name given by Professor Hunt to that principle of light which effects all changes, chemical or molecular, in substances. Prof. Hunt says: Light, heat, and photographic power are, beyond all doubt, three distinct classes of phenomena. Now, the science of optics has its nomenclature well confirmed by established use. The science of thermotics or of thermochroölogy is also considered of sufficient importance to have its nomenclature. It is, therefore, essential to the successful prosecution of our inquiries, that the third class of phenomena, which we have been particularly engaged in the consideration of, should have a term by which it might be distinguished. Might we not then, with strict propriety, regarding this principle as the sun's *energetic* power, working in and producing change in bodies, adopt such a term as energema, energy; or, slightly modifying it, use such a coinage as energia, which is capable of being readily adapted to all the combinations we are likely to require. If it was thought desirable to connect this name with the substantive *ray* for the purpose of expressing its origin more clearly, we might use actinergia; but it appears to me the whole subject would be kept more distinct and clear by the application of the epithet energia, simply to distinguish the principle without involving it in any way with its solar source or its radiant character.

Light, heat, and energia, for it is necessary to recapitulate, are the three principles (or the modifications of an elementary first principle) detected in the solar rays. The first acting upon the organ of vision, and enabling us to distinguish external objects, and giving color to all. The second is that principle which regulates the solid, liquid, or gaseous state of matter, and which maintains this planet in the condition which is essential to the well-being of its inhabitants. And the third, energia, is that power which effects all the changes, whether chemical or molecular, which are constantly in progress; it is that agent which is forever quickening all the elements of growth, and maintaining the conditions of a healthful vitality; and it is no less energetically employed in the processes of corruption, which, indeed, are no other than the necessary changes of matter in its progress from one state of organization to another. Melloni and M. E. Becquerel have both suggested the probability that the solar rays are but one principle—light; and that, as they are received upon bodies differently constituted, they produce the phenomena of color and vision, of heat, or chemical action. Melloni has, indeed, endeavored to explain all the phenomena of photographic action, and the peculiar influence of the dissevered rays of the prismatic

spectrum upon different preparations upon the supposition that all bodies, even those which are the most colorless, possess what he calls a *chemical coloration*. For example: if a sheet spread with the chloride of silver is exposed to the spectrum, we find that the greatest action takes place over the space on which the *blue rays* fall; whence it is argued, from a supposed analogy between the effects which would be produced if the spectrum was thrown upon a piece of blue cloth, in which case the blue ray would be exalted, that the *chemical color* of the white chloride of silver is chiefly blue. This system of reasoning is extended to all the chemical compounds which are known to undergo change of state by the influence of the solar power; and it is also used to explain the phenomena of absorption by colorless transparent fluids. It must be admitted that the memoir in which this philosopher sets forth his views is one of extraordinary excellence; but, although it will explain many of the phenomena, we have not a single fact which can be brought in support, otherwise than analogically, of this hypothetical view. Becquerel founds his assumption, as I have already stated, on the fact of the correspondence of the fixed lines detected in the different spectra. This fact does not appear to bear upon the argument. We already know that the physical properties of heat and light are similar—that they can be similarly reflected, refracted, and polarized; and the same applies to the chemical principle; but it is not, therefore, contended that we have arrived at such conclusions as would warrant our determining the identity of all the phenomena of heat and light. I do not mean to deny the possibility of their being modifications of some all-pervading principle, with which our researches have not, owing to their want of refinement, made us acquainted. The philosophy of chemistry teaches us to regard those bodies as elementary which do not admit of decomposition. But at the same time it imposes upon us the necessity of abandoning the idea that the solar radiations are a single independent element, when we can resolve them into three independent orders of phenomena. We now reckon three imponderable elements, light, heat, and electricity. Now, are we not bound by the principles which guide us in every step of the inductive system, to add to these a fourth —energia?

Energiatype. A process worked out by Hunt, also called Ferrotype, in which he showed the value of the salt of iron (protosulphate) as a developer. Energiatype was a process for obtaining prints direct in the camera, after-development, however, being necessary.

Engraved Blocks. Engravings cut upon blocks of wood. (See *Photography upon Wood.*)

Engraving on Glass. Producing pictures on glass in relief by means of hydrofluoric acid and photography. (See *Photographic Engraving on Glass.*)

Enlarging. The operation of obtaining an enlarged image from a small negative or positive is so called. Enlargements, either negatives or positives, may be obtained in many ways, of which the simplest is the use of an enlarging camera or lantern, obtainable commercially. Negatives to be enlarged should be as sharp as possible, free from even minute defects, possessing good gradation, detail, and contrast. Any good lens is suitable, preferably that with which the original was taken, if rectilinear. An ordinary camera may be used if it can be extended sufficiently to give an enlarged image of the desired size. Professional enlargers use either the solar or electric-light method, which are too complicated for the average worker. Enlargements on bromide or salted papers, or enlarged negatives, may be simply obtained as follows: Block out the whole of a window except a small space sufficiently large to take the negative to be enlarged; put the negative, film side toward the lens, into the rabbet-slide of the camera focussing screen; fix the camera close up to the space left in the darkened window so as to exclude all light except that coming through the negative, the lens being turned into the room. A reflecting-mirror or sheet of cardboard should be placed outside the window, to reflect light through the negative, at an angle of 45 degrees. In the darkened room a table or easel is placed at the proper distance to secure the desired enlargement, upon which the paper or plate is placed, perfectly vertical, to receive the enlarged image. The image on this sheet or plate is then focussed, and the exposure made, after which the enlargement is developed as usual.

Enlarging Ambrotypes. In this process the camera must be sufficiently large for the purpose, and capable of being extended to

the required length to obtain the size desired. A quarter-portrait combination lens should be used diaphragmed down to half an inch. The ambrotype to be enlarged should be placed in the sunlight, as directed for copying, and the image drawn on the ground-glass to the size required. For either an enlarged ambrotype or negative, the usual processes for ordinary pictures may be employed. (See *Copying.*)

Enlarging Apparatus. A contrivance by which enlarged photographic pictures are produced, either by artificial light or daylight. For direct positive enlargements from small negatives on bromide of silver paper an arrangement resembling the usual magic-lantern may be used, or a common camera, so arranged in the wall of a dark-room as to have the ground-glass illuminated from outside by daylight, and this increased by a reflector; the rest of the camera with the objective is in the dark-room. Opposite to it and at some distance an adjustable easel carries the bromide of silver paper. The negative to be enlarged is substituted for the ground-glass, the transmitted light projecting the picture upon the paper, which, after exposure, is developed into a positive enlargement.

Enlarging Camera. An instrument for copying and increasing the size of photographs. (See *Solar Camera.*)

FIG. 93.

Enlarging Daguerrotypes. For enlarging daguerrotypes, observe the same method as for copying, increasing the distance between the lens and the spectrum in correspondence to the increased size of the daguerrotype to be made.

Envelope. Used for displaying photographs. Made of various styles and sizes and supplied with a flap which, opening backward, makes the contrivance serve also as a stand for a photograph. (See Fig. 93.)

Eosin. $C_{20}Br_4H_8O_5$. Yellow, matt substance (coloring matter). Serves in the preparation of color-sensitive emulsions and films. Eosin, as well as the eosin colors derived from it, are very good sensitizers for green, yellow-green, and yellow in color photography. Mixed with silver salts, eosin forms a red precipitate (eosin of silver, bromo-eosin of silver), important for photography as an optical and at the same time a chemical sensitizer. (See *Erythrosin* and *Erythrosin of Silver.*)

Epsom Salts. (See *Magnesium Sulphate.*)

Equation. A making equal, or an equal division. *Equation of time* is the interval by which apparent time differs from mean time

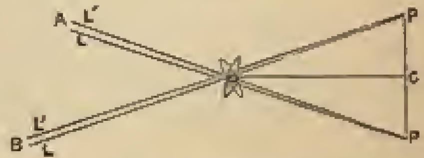
Equivalent. In chemistry, is the proportion expressing the weight, or quantity by weight, of any substance which combines with another substance to form a definite compound. This branch of science has undergone several changes in its nomenclature, and is now named the doctrine of definite proportions. The words atom, combining, quality, proportional, prime number, etc., have been employed by different authors to express the same meaning as the phrase now generally adopted. It may be considered under three heads or general propositions: the first of which is, *that bodies combine in certain fixed or definite proportions, as may be exemplified in the union of chlorine and hydrogen, oxygen and bismuth.* Thus, 36 parts of chlorine combine with 1 part of hydrogen and form 37—or one part muriatic acid; but these bodies do not combine in any other proportions. There are many substances which can combine with more than one determinate proportion; but no combination can be formed intermediate between these; thus, copper combines in the proportion of 64 parts with 8 or 16 of oxygen, and mercury in the proportion of 200 parts with 8 or 16 of oxygen, and with no other quantity. The second head, or law, for consideration is, *that when any two bodies are combined with any given weight of a third substance, and then*

brought into combination with each other, they combine together in the same proportion in which they had previously united with this third substance. For example: 6 parts of carbon will unite with 1 part of hydrogen and 8 parts of oxygen; from this circumstance we infer from our knowledge of the law of definite proportions, that they will unite with each other in the same proportion, or, in other words, that 1 part of hydrogen will unite with 6 of carbon, and that 8 of oxygen will also combine with 6 of carbon. In this manner the combining proportions of bodies are determined, and whatever substance we may select as a standard of comparison, it will only be necessary to number the other bodies in relation to the number we have attached to the point of comparison in order to determine the proportion in which bodies combine with it and with each other. Dr. Wollaston introduced the term chemical equivalent to denote the numbers representing the proportionate quantity in which different bodies combine together; thus, if the standard of comparison be hydrogen 1, carbon will be 6, oxygen 8, nitrogen 14, sulphur 16, zinc 34, etc. which numbers will be the chemical equivalents of their respective substances. The chemical equivalent of compounds is made up by adding together the numbers representing the simple substances of which they are formed; thus, water is represented by the figure 9, 8 oxygen + 1 hydrogen, of which it is composed. The third proposition is, *that when one body combines with another in more than one definite proportion, the quantity of one of them in the different combinations will be found to be double, triple, or some simple multiple of the smallest proportion in which it combines with a given quantity of the other substance.* For example: copper, 64 parts, will unite with oxygen, 8 parts, to form a compound known as the protoxide of copper. The same quantity, 64 parts, will also unite with 16 of oxygen to form another compound of the same metal, the deut-oxide. Gay-Lussac found that a peculiar law was also observable in the union or combination of gases; he found that, when they unite together, the bulk of the one always bears a simple ratio to the bulk of the other. For example: half a volume of oxygen combines with one of hydrogen and one of nitrogen; 1 volume of nitrogen combines with 3 of hydrogen. When bodies unite in more than one proportion the quantity of one of the combining substances is increased by some simple multiple of the smallest quantity of it which enters into the first combination. The general laws in reference to the combination of gases have been denominated the theory of volumes, and by comparison will be found to agree exactly with the theory of definite proportions.

Equivalent Focus. To find the equivalent focus of a portrait combination, the following is suggested:

1. A and B are the distant objects, from which the rays L and L′ are brought to a focus at P P′ on the ground-glass, equidistant from the centre C, and the distance P P′ is measured with compasses. (These rays are what are termed "parallel rays," the distance of the object being so great, in com-

FIG. 94.



parison with the focal length, that they may be considered parallel.) The camera is now turned until the image of A moves from P to C, and the line O P is drawn along the edge of the camera on the paper underneath. Then the image P′ of the object B is similarly brought to C, and the line O P′ is drawn. Next, the triangle O P P′ is completed by setting off the base P P′, and the legs, O P, O P′, are evidently the focal distance. (For simplicity of figure, a single lens is taken; the principle is evidently exactly the same for a combination.)

2. The same figure will serve to illustrate the second method. In this, the two points P and P′ are first arbitrarily marked on the ground-glass so that the image of a single distant object, A, shall fall on P, and the line O P is drawn on the paper by the side of the camera. The camera is then rotated till the image of *the same* distant object falls on the mark P′, and the line O P′ is obtained. The construction in this case is evidently the same as before.

Equivalent Numbers. The proportions in which substances combine are expressed

by fixed numbers, or by the multiples of these numbers; these are termed equivalent numbers: for example, *copper*, 1 part = 64 combines with 1 of *chlorine* = 36 forming *chloride of copper* = 100, the equivalent number of the last-named salt. (See *Equivalent Proportions*.)

Equivalent Proportions. When elementary or compound bodies enter into chemical union with each other, they do not combine in indefinite proportions, as in the case of a mixture of two liquids, or the solution of a saline body in water. On the other hand, a certain definite weight of the one unites with an equally definite weight of the other; and if an excess of either be present, it remains free and uncombined. Thus, if we take a single grain of the element hydrogen, to convert that grain into water there will be required exactly 8 grains of oxygen; and if a larger quantity than this were added, as for instance 10 grains, then 2 grains would be over and above. If separate portions of metallic silver, of 108 grains each, were weighed out, in order to convert them into oxide, chloride, and iodide of silver respectively, there would be required 8 grains of oxygen, 36 grains chlorine, 126 grains iodine. Therefore, it appears that 8 grains of oxygen are equivalent to 36 grains of chlorine, and to 126 grains of iodine, seeing that these quantities all play the same part in combining; and so it is with regard to the other elements; to every one of them a figure can be assigned, which represents the number of parts by weight in which that element unites with others. (See *Equivalent Numbers*.) These figures are the "equivalents" or "combining proportions," and they are denoted by the symbol of the element. (See *Symbolic Notation*.) The law of equivalent proportions applies to compounds as well as to simple bodies, the combining proportion of a compound being always the sum of the equivalents of its constituents. Thus, sulphur is 16, and oxygen 8, therefore sulphuric acid, or SO_3, equals 40. The same rule applies with regard to salts. Take, for instance, the nitrate of silver; it contains

Nitrogen	14	(equivalent)
6 Oxygen	48	"
Silver	108	"
Total of equivalents, or equivalent of nitrate of silver.	170	

The utility of being acquainted with the law of combining proportions is obvious when their nature is understood. As bodies both unite with and replace each other in equivalents, a simple calculation shows at once how much of each element or compound will be required in a given reaction. Thus, supposing it be desired to convert 100 grains of nitrate of silver into chloride of silver, the weight of chloride of sodium which will be necessary is deduced thus: 1 equivalent, or 170 parts, of nitrate of silver is decomposed by an equivalent, or 60 parts, of chloride of sodium. Therefore, as 170 : 60 : : 100 : 35.2; that is, 35.2 grains of salt will precipitate, in the state of chloride, the whole of the silver contained in 100 grains nitrate. In the scale of equivalents now usually adopted, hydrogen, as being the lowest of all, is taken as unity, and the others are related to it.

Erythrosin. A beautiful red eosin-coloring matter, barely soluble in water, but quite so in alcohol and in alkalies. Used in the preparation of color-sensitive emulsions and plates, rendering them sensitive for yellow and green. When exposing such plates a yellow screen should be used in the camera as a light-filter.

Erythrosin of Silver. A combination of nitrate of silver and erythrosin. Serves the same purpose as erythrosin, but is a much more powerful sensitizer for yellow than the latter, and producing a considerably higher general sensitiveness of the plate. When using such plates, a yellow screen is not needed, except when copying paintings, showing much blue color.

Essential Oils. Essential (*or volatile*) oils are chiefly obtained from the flowers, leaves, fruit, seeds, bark, and roots of plants, by distilling them with water. They are usually more limpid and less unctuous than the fixed oils; but some of them are butyraceous or crystalline. The majority, when perfectly pure, are colorless, though before rectification nearly the whole of them have a pale-yellow tint and some of them are brown, blue, or green. Their density fluctuates a little on either side of water, and they are sparingly soluble in that fluid, forming perfumed or medicated waters. They possess various degrees of volatility, and evolve the odor of the plants from which they are distilled. By exposure to the air they rapidly absorb oxygen and become partially converted into resin. This is the cause of the deposit that

usually forms in them. Some of the essential oils are used in photography as solvents, and in a few photographic processes.

Etching. By etching is understood the deepening of parts of different metals, stone, glass, or other materials, by an application of dissolving solutions, and is divided into two classes, namely: deep etching and relief etching. The fluid used depends on the different materials to be wrought upon. For etching upon iron and steel a weak solution of muriatic acid is used, but for reproducing engravings use solutions of pyroliguous acid, alcohol, and nitric acid, a solution of iodine and iodide of potassa, in water, and a solution of corrosive sublimate, alcohol, and a trifle of nitric acid. Etching on copper plates is done with a solution of weakened nitric acid, or a solution of copper chromate and muriate of ammonia, diluted with vinegar or chlorate of potassa. Brass and silver are etched with weakened nitric acid only; gold with nitro-muriatic acid; zinc with nitric acid, pyroligneous acid, and chloroacetic acid. The lithographic stone is etched with nitric acid or muriatic acid; glass with hydrofluoric acid, or if a dim appearance of even deepness is desired, use a solution of 250 grains potassa fluorate, 140 grains sulphate ammonia, mixed in 250 grains muriatic acid and 1000 grains of water. With a solution of ammonia fluorate, writing may be put on glass, having a dim effect. Agate, rock-crystal, jasper, and chalcite should be etched with hydrofluoric acid. Marble and mother-of-pearl require weakened nitric acid, and amber and ivory, pure sulphuric acid. (See *Half-Tone*, *Zinc-Etching*, *etc.*)

Etching Daguerrotypes. (See *Electro-Etching*.)

Etching on Glass. The following method of transferring photo-lithographs and collotypes to glass is recommended by Mons. A. M. Villon: A print on glazed paper is made from the block with the following color: 3 parts stearic acid, 2 parts asphalt, 3 parts oil of turpentine. The print is then held over a saucer containing a mixture of 1 part hydrochloric acid and 4 to 6 parts water till the hydrochloric acid fumes have condensed upon it. It is then floated on lukewarm water till the colors have softened, when it is laid upon the surface of the glass with the image downward, and pressed flat with an India-rubber roller. The back of the paper is then moistened with a wet sponge, one corner of it raised, and it is then stripped rapidly off. The glass is then etched with hydrofluoric acid in the ordinary way.

Etching-Paper. The rough, stout paper used for etchings has been recommended as an excellent mount for artistic landscapes of small or large size, printed in carbon, or upon any matt-surface paper.

Etchzaic. A name given by Mr. C. Ashleigh Snow to a superior half-tone etching which has had special manipulation by his own methods.

Ether. Ether is one of the most important chemicals used in photography. It is obtained by distilling equal parts, by weight, of sulphuric acid and alcohol. If the formula of alcohol be compard with that of ether, it will be seen to differ from it in the possession of an additional atom of hydrogen and of oxygen; in the reaction the sulphuric acid removes these elements in the form of water, and by so doing converts one atom of alcohol into an atom of ether. The term *sulphuric*, applied to the commercial ether, has reference only to the manner of its formation. Ether is neither acid nor alkaline to test-paper. Specific gravity, at 60°, about 0.720; boils at 98° F. The vapor is exceedingly dense, and may be seen passing off from the liquid and falling to the ground; hence the danger of pouring it from one bottle to another if a flame be near. It does not mix with water in all proportions; if the two are shaken together, after a short time the former rises and floats on the surface. In this way a mixture of ether and alcohol may be purified to some extent, as in the common process of *washing* ether. The water employed, however, always retains a certain portion of ether and acquires a strong ethereal odor; washed ether also contains water in small quantity. Bromine and iodine are both soluble in ether, and gradually react upon and decompose it. The strong alkalies also decompose ether, slightly, after a time, but not immediately. Exposed to air and light, ether is oxidized and acquires a peculiar odor. It dissolves fatty and resinous substances readily, but inorganic salts are mostly insoluble in this fluid. Hence it is that iodide of potassium and other substances dissolved in alcohol are precipitated, to a certain extent, by the addition of ether. The purity of the ether employed is a matter of as much importance in the manufacture of collodion as that of any

other ingredient; this point must be attended to in order to secure good results. Some of the characteristics which render ether unfit for photographic purposes are: a peculiar and disagreeable smell, either of some essential oil, or of acetic ether; an acid reaction to test-paper; a property of turning alcoholic solution of iodide of potassium brown with unusual rapidity; an alkaline reaction to test-paper; a high specific gravity (it should not be higher than 0.720) from superabundance of alcohol and water. Ether which has been re-distilled is always the most uniform in composition, and especially so if the second distillation be conducted from quicklime, carbonate of potash, or caustic potash. These alkaline substances retain the impurities, which are often of an acid nature, and leave the ether in a fit state for use. The re-distillation of ether is a simple process. In dealing with this fluid, however, the greatest caution must be exercised, on account of its inflammable nature.

Take ordinary sulphuric ether and agitate it with an equal bulk of water to wash out the alcohol; let it stand for a few minutes until the contents of the bottle separate into two distinct strata, the lower of which (water) is to be drawn off and rejected. Then introduce caustic potash finely powdered, in the proportion of 1 ounce to 1 pint of washed ether; shake the bottle again in order that the small portion of water still remaining may be thoroughly absorbed. Afterward, set aside for twenty-four hours (not longer), when it may be probably observed that the liquid has become yellow and that a flocculent deposit has formed in small quantity. Transfer to a retort of moderate capacity, supported in a saucepan of warm water and properly connected with a condenser. On applying a gentle heat, the ether distils over quietly, and condenses with very little loss. Care must be taken that none of the alkaline liquid contained in the body of the retort finds its way, by projection or otherwise, into the neck, so as to run down and contaminate the distilled fluid. In order to preserve ether from decomposition, it must be kept in stoppered bottles, nearly full, and in a dark place. The stoppers should be luted and tied over with bladder.

Ether is used photographically in the manufacture of collodion and some kinds of varnishes, and in the preparation of some papers.

Ethoxo-Limelight. It has been suggested that for optical projection ether may be used as a substitute for the hydrogen gas. A light obtained by a mixture of ether and oxygen is called the ethoxo-limelight. The use of hydrogen gas, however, is more convenient and safer in practice.

Euryscope. A double objective, constructed by Voigtländer (symmetric), intended for all classes of photographic work. Very like the aplanats in construction, possessed of great sharpness and depth, and twice as rapid as the orthoscope.

Evanescent. Vanishing; fleeting; volatile; liable to dissipation, or to become imperceptible.

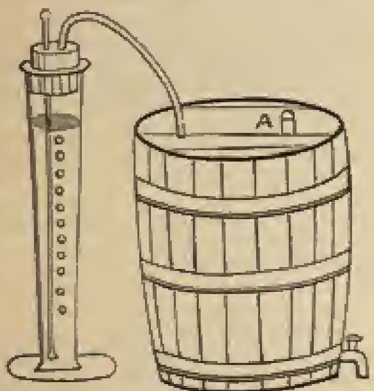
Evaporate. To pass off in vapor; to escape and be dissipated, either in visible vapor or in particles too minute to be visible; to convert or resolve a fluid into vapor.

Evaporation. The dissipation of a fluid by means of heat. Evaporation is had recourse to, either for the purpose of recovering a solid body from its solution, or to strengthen a solution by the expulsion of some of the fluid matter that forms the menstruum. Under ordinary circumstances, it is confined to the surface of the heated liquid, and is therefore either slower or quicker in proportion to the extension of that surface. Hence has arisen the adoption of wide, shallow vessels for containing fluids during their exposure to heat for this purpose. It has been found that evaporation proceeds more rapidly when a current of air is made to pass over the surface of the fluid, as in this case the vapor is prevented from resting on the surface and impeding the process by its pressure. On the small scale, shallow capsules of glass, Wedgewood-ware, porcelain, or metal are commonly employed as evaporating vessels, and then are exposed to heat by placing them over a lamp or naked fire, or in a water-bath, or sand-bath, according to the temperature at which it is proper to conduct the process. The term "spontaneous evaporation" is applied to the dissipation of a fluid by mere exposure in open vessels, at the common temperature of the atmosphere, and without the application of artificial heat. The celerity of this kind of evaporation wholly depends upon the degree of humidity of the surrounding air, and differs from the former, in which the rate of evaporation is proportionate to the degree of heat at which the process is conducted and

the amount of pressure on the surface of the liquid. Evaporation *in vacuo* is conducted under the receiver of an air-pump, or in an attenuated atmosphere, produced by filling a vessel with steam, by which means the air is expelled, when all communication with the external atmosphere is cut off, and the vapor condenses by the application of cold. Fluids are also evaporated in air-tight receivers over sulphuric acid, by which they are continually exposed to the action of a very dry atmosphere. When such a receiver is connected with an air-pump in action, evaporation proceeds with increased rapidity, and intense cold is produced.

Evaporator for Silver Solutions. A filled bottle is closed by a stopper perforated by two holes through which one short and one long glass tube passes, reaching down to the

FIG. 95.



bottom. To the short tube an India-rubber tube is fastened and the other end of it is connected with a barrel of water. As soon as the water is turned on the air is drawn through the long tube and bubbles up through a silver solution, removing all the alcohol in a very short time. A is a hole to insert the funnel for filling the barrel with water, now closed.

Excess. In chemistry, more than the proper proportion; more of one ingredient than another; more than can be dissolved by a given quantity of fluid.

Excite. In photography, to sensitize; to render a plate or paper sensitive to the light.

Excited. When a plate or paper is rendered sensitive to the light, it is termed *excited*.

Exciting. The act of applying a sensitive substance to the photogenic plate or paper, either by immersion or rubbing.

Exciting Bath. The sensitizing solution into which the plate or paper is immersed to render it impressible by light.

Expansion of Paper. Most kinds of paper expand when wetted. This fact is of importance in printing portraits, when care should be taken to cut the pieces of paper so that they will all expand in the same direction, to avoid distortion in the finished prints. It is also important in preparing litho-transfers when registration of several images is required.

Exposure. In photography, the act of submitting the daguerrotype plate, or photogenic glass, or paper, to the action of light, either in the camera or in the printing-frame. There are different methods of using the camera to obtain photographic impressions; but the one in general use is to place the camera in its proper position, and when the object is brought to show well upon the ground-glass, withdraw the latter and put the coated plate in its place. When the ground-glass is withdrawn, care should be taken not to remove it too suddenly, or particles of dust in the camera may be set in motion, which, by settling on the plate, would form black specks and spoil the picture. Before removing the ground-glass, also, be sure to replace the cap of the tube. After the dark-slide has been removed from the plate-shield, the cap should be removed from the tube and the light admitted into the box. As the time of exposure depends upon the intensity of the light and the quality of the lens, it is impossible to give definite instructions in the matter; and experience alone must determine how long each plate is to be exposed. In determining the time, some account must be taken of the color of the object to be copied, as all colors are not equally photogenic. Thus the yellows, light greens, and reds, and other bright colors, have very little action. The photogenic intensity of light decreases very sensibly in proportion as the sun approaches the horizon. Thus on a fine summer's day, with a cloudless sky, between the hours of ten and four, small fractions of seconds only are necessary for most exposures, whilst before and after those hours a

much longer time is necessary. We must also take into account the state of the atmosphere, as the exposition is much retarded if it is the least hazy, or of a yellowish appearance. In the event of the first attempt failing, the operator should make another immediately, and he may be almost certain of succeeding in this second trial. The following are some of the indications by which the operator will know whether he has left the plate in the camera too long or too short a time. For the *daguerrotype*, the exposition will have lasted too long, and the impression will be "*burnt*" or "*solarized*," when all the objects are apparent, but with an inverse intensity to that which they had in Nature; that is to say, the whites have become bluish, and those parts which should be black are more or less approaching to white. It will be known when the plate has not remained sufficiently long, when those objects *only* which have received most light are reproduced *very distinctly*, and when the other objects appear distinctly traced and too dark, or else are not at all apparent. For the *collodion plate* the indications are: If a *positive* be *under-exposed*, the features have an unnatural black and gloomy appearance, the dark portions of the drapery, etc., being invisible; if *over-exposed*, the face is usually pale and white, and the drapery indistinct and misty. Much, however, depends upon the dress of the sitter and the manner in which the light is thrown; if the upper part of the figure is shaded too much, the face may be, perhaps, the last to be seen. In a *negative* the *under-exposed* plate develops slowly. By continuing the action of the developer, the high lights become *very black*, but the shadows are invisible, nothing but the yellow iodide being seen on those portions of the plate. After treatment with the fixing agent, the picture shows well as a positive, but by transmitted light all the minor details are invisible; the image is black and white without any half-tone. An *over-exposed* negative develops rapidly at first, but soon begins to blacken slightly on every part of the plate. After the fixing often nothing can be seen by reflected light, but a uniform gray surface of metallic silver, without any appearance (or at most, a very indistinct one) of an image. By transmitted light the plate may appear of a red or brown color, and the image is faint and dull. The clear parts of the negative being obscured by the fogging, and the half-shadows having acted so long as nearly to overtake the lights, there is a want of proper *contrast*, hence the over-exposed plate is the exact converse of the under-exposed, where the contrast between lights and shadows is too well marked, from the absence of intermediate tints. A negative which has received the proper amount of exposure will possess the following characteristics after development: The image is partially but not fully seen by reflected light. In the case of a portrait, any dark portions of the drapery show well as a positive, but the features of the sitter are scarcely to be discerned. The plate has a general aspect as of fogging *about to commence*, but not actually established. By transmitted light the figure is bright, and appears to stand out from the glass; the dark shadows are clear, without any misty deposit of metallic silver; the high lights *black* almost to complete opacity. The *color* of the image, however, varies much with the state of the bath and collodion, and with the brightness of the light. When you have shut off the light, take the same care in closing the slide of the shield as recommended for placing the shield in its place, to avoid particles of dust.

Expression. In art, the distinct and natural exhibition of character, or of sentiment in the characters represented. Expression is a general term, implying a representation of an object agreeably to its nature and character, and the use or office it is to have in the picture or statue. The *force* of expression is not generally sufficiently studied by photographers; hence it is that the large majority of photographs represent the subject with a sameness of attitude and general characteristics that make them disagreeable and in some cases disreputable. Every photographer, when called upon to take the portrait of a lady or gentleman, should by some means possess himself of a knowledge of the main characteristics, tastes, and habits of his sitter, and endeavor to bring out the most prominent feature so as to represent it in the picture. Rules are worthless in this branch of the art. If the operator has not the natural taste and ability to seize at once the whole nature of expression necessary to represent his sitter truthfully, he is unfit to practise the beautiful art of photography.

Expresstype. A process, so named by W. Cronenberg, in whose institute it is taught.

F.

Fabrics, Printing on. Prints from photographic negatives may be obtained on almost any textile fabric by various methods. For the production of prints in colors on linen, cotton, or silk, see *Diazotype Process*. Linen coated with gelatino-bromide emulsion is obtainable commercially, on which bromide prints suitable for a variety of artistic and commercial purposes may be had. Villani has recently made known a process of photodyeing by which colored prints are obtainable on any fabric. In this process the fabric is treated with a bichromate and ammonium metavanadate and then exposed to light. It is then brought into contact with a derivative of anthracene, and a colored print results. For printing on cotton, silk, or woollen fabrics, or canvas for painting, immerse the fabric in a solution made up of:

Ammonium Chloride	2 parts.
Water	250 "
Whites of two eggs.	

When dry, sensitize by immersion in a 60 or 70 grain silver bath. Tone, fix, etc., as usual. (See *Printing*.) Ready-sensitized silk is obtainable.

Facsimile. An imitation of an original in all its traits and peculiarities. A photographic copy of an object is a facsimile of that object.

Fading. Losing color; becoming less vivid; decaying; losing freshness or vigor. Unfortunately photographs are very liable to destruction from certain causes, which destruction is termed *fading*. The principal causes of fading are: *imperfect washing; over-toning; imperfect fixation; acid matter left in the paper after washing; moisture; the mode of mounting; sulphuretted hydrogen from the atmosphere; bad paper*. Keeping deleterious chemicals in the toning room will also cause fading. In washing the print it is absolutely necessary to get rid of every particle of the hyposulphite of soda taken up by the paper during fixing, or sulphurization takes place, which eventually destroys the picture. From 12 to 16 hours' immersion in running water is necessary to effect this, and a little after-sponging will do no harm. If running water is not to be had the prints must be soaked in several changes of water, and well sponged on both sides over a glass slab, or passed through pressure rollers repeatedly until the taste of hyposulphite of soda is not perceptible. (See *Washing Machine*.) It is also necessary that all acidity should be washed out, or got rid of previous to washing, by submitting the print to very weak dilute aqua ammoniæ, say 3 or 4 drops to the pint of water. Over-toning can be avoided by watching the operation closely, so as to avoid "yellowing" the high lights of the print. When sufficiently toned (either when the toning and fixing are done separately or at the same time), the high lights will present a brilliant whitish appearance and the shadows will be clear and semi-transparent; at this stage, no matter what the *color* may be the print should be taken out and placed in the washing-trough. The yellowing of the print indicates sulphurization, and, although this does not always cause fading, it should be avoided. Imperfect fixation is the result of either too short or too long immersion in the bath; the proper length of time is indicated by the brilliancy of the whites and clearness of the shadows by reflected light, and the disappearance of the transparent mottled appearance, at first given by the hyposulphite, by transmitted light. With care in these manipulations permanency may be obtained, provided we use paper of a firm texture and hard size. Mount the prints on neutral cardboard with pure fresh starch or gum-arabic paste; protect them from moisture and the attack of sulphuretted hydrogen from the atmosphere. We should also mention that care should be taken, in the drying, to hang the prints in a room free from deleterious vapors, which may arise from coal gas, or any obnoxious chemical, such as cyanide of potassium, hydrosulphuret of ammonia, or potassium. (See *Sulphuretting*.)

Fahrenheit. (See *Thermometer*.)

Falling Front. In some cameras, intended for outdoor work, the front board on which the lens is fixed is so constructed as to be movable upward or downward, so as to obtain more or less foreground in the picture as desired. This is called a rising or falling front. It is only to be used with care, as the shifting of the lens, up or down, alters its position with regard to the centre of the plate, and causes unequal illumination.

Fargier's Carbon Process. Up to the moment when the plate is impressed by the action of light, Mr. Fargier's process is identical with Mr. Pouncy's, or, what is the same,

with Mr. Poitevin's; but beyond that point no similarity exists. He takes pure white gelatine, as free from alum as possible, and dissolves about 2 drachms in 1 pint of water; to this solution he adds a drop or two of ammonia to precipitate any alum that may be present, and then incorporates 15 grains of the purest carbon intimately with the liquid. The best carbon is that obtained from the combustion of coal gas. To effect the complete incorporation of the carbon with the solution of gelatine, the mixture should be well worked under the pestle in a glass or porcelain mortar, adding also 15 grains of bichromate of potassa, previously dissolved in the smallest possible quantity of water. A portion of this mixture is poured upon a piece of plate glass, and dried at a gentle temperature, not exceeding 140° F. This done, the plate is placed under a negative and exposed to light for one or more minutes, according to the intensity of the light. Thus far Mr. Fargier's process presents no novelty; but thenceforward it differs very materially from other known processes. In the latter, when the plate is conveyed to the dark-room, it is washed with water, to remove such portions, of the gelatine as have not been acted upon by the light, leaving the insoluble portions which form the picture by the carbon they contain. But Mr. Fargier does not proceed in this fashion; for experience has shown that this rough mode removes all the half-tones and leaves only the opaque blacks, in consequence of the solution of these portions of the gelatine contiguous to the slightly colored portions of the image. To avoid this inconvenience, he has overcome the difficulty in a very ingenious manner. Instead of washing the upper surface of the gelatine, that which has received the luminous action, in a direct manner, he places it on a suitable support, and then washes the lower surface of the film, so that only such portions as are really soluble are removed, leaving upon the support the most delicate half-tones and the finest details. To accomplish this result, he proceeds as follows: When the plate is taken from the printing-frame into the dark-room, he pours all over the gelatine surface a layer of thick non-iodized collodion; when this has become dry, he places the plate in a dish of water, collodion uppermost. The water penetrates beneath the collodion and softens the gelatine, which soon becomes completely detached from the plate and floats in the water; the glass is then removed and the washing cautiously continued. When this is concluded (it must be performed in a dish with a white bottom and perfectly flat), a sheet of gelatinized paper is dextrously applied to that surface of the gelatine which was originally in contact with the glass. It adheres with the greatest facility to the paper, and presents, when dried, a perfect picture with all the charms of Nature's chiaroscuro. In dextrous hands very beautiful results may be obtained.

Feertype. The name given to colored prints produced by the Diazotype process invented by Dr. Feer, which see.

Fermentation. This term is generally employed to designate the spontaneous decomposition of dead organic matter. When vegetable and animal matters are exposed to the action of the atmosphere, heat, and moisture, changes occur in their composition; the union of their ultimate components is destroyed, and the particles thus set at liberty recombine, but in such a manner as to form new compounds entirely different from the substances from which they were generated; the most common result of these changes is the formation of alcohol, carbonic acid, acetic acid, and a nauseous unpleasant smell.

Ferrier's Albumen Process. A plate of glass of the stereoscopic size is first cleaned and then stuck upon a holder having a long handle. It is first held horizontally and iodized albumen is poured over it. It is then held in a vertical position with the stick between the hands, and made to revolve *slowly*, always in the same direction, so as to drive off the excess of albumen. The iodized albumen is made thus: 10 grains iodide of potassium are dissolved in a few drops of water, and the solution added to the white of one egg; the whole is then beaten up, allowed to settle, and strained in the usual way. The albumenized plate is next dried in a drying-box in the following way: The box is made with grooves like a common plate box, into which the plates are put, but so far apart as to allow of the insertion between every pair of a thin piece of hot baked porous wood, which absorbs the steam and dries them in a few hours. Any dust which may get upon the plate while drying may be removed before sensitizing with a fine-pointed stick, holding the plate on a level with the eye between it and the light. To excite the dried albumenized

plate it is immersed in a bath of aceto-nitrate of silver which long use has rendered as black as ink. It is then washed in distilled water and dried. The views are not taken in a binocular camera, but with only one lens, and one after the other, from stations wide apart. The right picture is taken on the left end of the plate and *vice versa*, so that there is no need to cut the negative in order that the prints may come right in the stereoscope. The development is effected by a saturated solution of gallic acid with a little nitrate of silver added. The gallic acid is filtered into a small silver cup, and heated to 180° over a spirit lamp. A few drops of aceto-nitrate are then added, and it is immediately poured over the plate, which has previously been wetted in a dish of water. This hot developer brings out the image very quickly, and after a time the plate becomes stained. The developer is then poured off and the stains cleaned away by rubbing the film with a tuft of cotton-wool. After this apparently rough treatment, which does no harm to the film, some fresh developer is heated and poured on as before; and this is repeated until all the details are brought out and proper intensity obtained. The picture is then fixed in hypo, and washed in the usual way. No varnish is required.

Ferric Acid. This acid is prepared by mixing 2 drachms finely pulverized iron filings with 4 drachms pulverized saltpetre in an 8-ounce crucible, heating to a glowing red on red-hot coals. When combination takes place on one side, shown by the evolution of light and white fumes, remove it from the fire. As soon as the deflagration of the mixture has ceased, scrape out the mass on a cool plate by means of an iron spatula. The product is a dark-reddish mass, forming a superb cherry-red solution with water, which quickly undergoes decomposition.

Ferric Oxide. Oxide of iron, protoxide of iron, peroxide of iron, are all combinations of iron with oxygen in different proportions. From these oxides result salts, many of which are useful in photography.

Ferric Salts. Combinations of the oxides of iron with acids and other substances, and forming a class of salts very useful in photography, but the natures of all of which have not been fully investigated. Many of them have been used in the preparation of sensitive papers, but their management is not yet under complete control. The use of the salt protosulphate of iron in developing is the only one well understood by operators. (See *Ferro-Cyanotype*, *Energiatype*). The protosulphate and protonitrate of iron are the two iron salts most useful in photography and are principally devoted to the developing process. (See *Development*, *Protosulphate and Protonitrate of Iron.*)

Ferric Salts. Iron enters into two combinations with oxygen and acids: (1) ferrous salts; (2) ferric salts; the first are mostly soluble in water, of greenish color, readily oxidize to a still higher degree, and act as reducers; their addition throws down the precious metals from their solutions in the form of powder. Ferric salts are of yellow to reddish-yellow color (exceptions: ferrous oxalate is brown, ferric oxalate green), and do not act as reducers. Ferric oxide, both that found in Nature and the artificially prepared, is used for polishing glass and metals.

Ferricyanide of Potassium. Red prussiate of potash. $K_3Fe(C_6N)_6$. Red, brilliant crystals, making a yellow powder. It is used in gelatine emulsion for reducing too intense negatives and in the uranium intensifier.

Ferrocyanide of Potassium. Yellow prussiate of potash. $K_4Fe(C_6N)_6+3H_2O$. Large light-yellow crystals used as an accelerator in pyrogallic and hydroquinone developers.

Ferrocyanate of Potash. The ferrocyanate of potash may be procured by digesting Prussian blue in liquor of potassa, until the alkali is neutralized, filtering to separate the peroxide of iron, and evaporating the fluid, when lemon-colored transparent four-sided tabular crystals, soluble in less than their weight of water, perfectly neutral, inodorous, and having a slightly bitter taste, will be procured. When exposed to a temperature of less than 212° F., each equivalent of the salt parts with three equivalents of water. A solution of this salt is used to fix the energiatype picture. (See *Energiatype*.)

Ferro-Cyanic Acid. This acid contains 3 equivalents of cyanogen, 1 of iron, and 2 of hydrogen, its equivalent number being 108. It is obtained by adding to the ferrocyanate of potash in solution a solution of hydrosulphuret of barytes, as long as any precipitate takes place, and filtering, the precipitate being washed and dissolved in a

quantity of water, is to be decomposed by sulphuric acid, taking care not to add it in excess; a sulphate of baryta will be precipitated and the acid obtained in solution. By allowing the solution to evaporate spontaneously the ferro-cyanic acid may be procured in yellow crystals of a cubic form. It reddens the vegetable blues and neutralizes the salifiable bases; it is decomposed by exposure to light, absorbing oxygen, and depositing Prussian blue.

Ferro-Cyanotype. (See *Cyanotype*.)

Ferro-Tartaric Acid. This acid is composed of 1 equiv. tartaric acid, 1 protoxide of iron and 2 water, its equivalent number being 120. This has been used in the cyanotype process by adding a solution of nitrate of silver of the specific gravity 1.200 to the acid, sp. gr. 1.023. A precipitate falls which is entirely re-dissolved by moderate heat, and a yellowish liquid is obtained. This solution is spread upon the paper and exposed while moist to the light for a few seconds; at first no impression is seen, but soon, even away from the influence of light, it develops in an instant, and at last becomes intensely black. If the paper has been thorougly dried in the dark it possesses the singular property of receiving an impression imperceptible to the eye, but which becomes instantly visible by breathing upon it, or by holding it over steam.

Ferrotype. This name was once given to the energiatype process, devised by Robert Hunt. It is now exclusively applied to the process by which collodion positives are produced on thin iron plates.

Ferrotype Process. A method of making direct positives in the camera on black or chocolate-colored iron plates, highly varnished. They may be made by the wet collodion or dry gelatino-bromide of silver process.

Ferrous Oxalate (Peroxalate of Iron, Sesquioxalate of Iron). $Fe_2(C_2O_4)_3$. Yellow precipitate, difficult of solution, formed by treating chloride of iron with oxalate of potash. Used as retarder in oxalate of iron developer, also as reducer of over-intense negatives, and in the preparation of platinum paper.

Films. Transparent skins, coated on one side by bromide of silver gelatine emulsion, used instead of glass plates. These films are made of gelatine, collodion, celluloid, or isinglass. They have the advantage of being lighter and less fragile than glass. They are sold in rolls, or cut to size. Sheets of celluloid film, or gelatine with a matt surface, are adapted to many uses in photographic work, such as focussing screens, as a support in some of the photo-mechanical processes, and for the production of lantern slides by other than photographic methods. Such screens are also used for the production of soft effects in photographic printing.

Film Side. That side of the plate, or film, which is coated with the light-sensitive preparation.

Film Photography. By means of transparent celluloid films, coated with gelatino-bromide emulsion, all kinds of photographic work can be done, without the use of glass or paper as the support for the sensitive surface. Although the use of films instead of glass was suggested by W. B. Woodbury, as early as 1871, it has only been made practicable during the last ten years. Excellent gelatino-bromide films are now obtainable commercially, the best being those manufactured by Carbutt, Seed, and Eastman. The principal advantages obtained by the use of films instead of glass plates are the saving effected in weight and bulk, non-liability to breakage in transportation and manipulation, less tendency to halation, and the small amount of room required for storage. A gross of plates, packed, will measure 16 inches in height, while the same number of films measure only 4 inches and weigh less than one-sixth the weight of the plates. Gelatino-bromide films, orthochromatic and otherwise, are especially adapted for tourist or hand-camera work. The manipulation of films is in almost all respects identical with that of glass plates; for use in the camera they require a film-carrier in place of the usual plate-holder; it is better to develop films singly, fitting them into a varnished metal carrier or frame to keep them flat during development. A prepared developer is obtainable commercially which has the property of flattening films, obviating any tendency to curl; its composition is unknown.

FIG. 96.

Filter. A strainer; a piece of cloth, paper, or other substance through which liquids

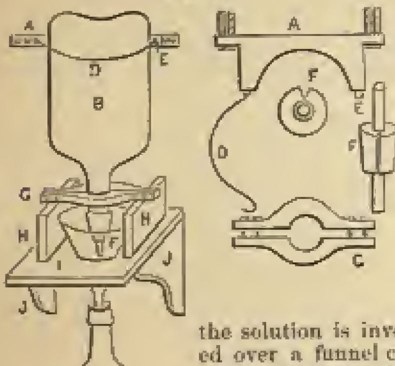
are passed to remove impurities or foreign matter. A filter for photographic purposes is best made by using a funnel and inserting a piece of filtering paper: take a rectangular piece of paper and fold it as indicated by the diagram, Fig. 96.

Filtering. To purify a liquid from suspended impurities by mechanical means. For this, porous substances are used such as unsized paper, flannel, cotton, etc., which allow of the liquid passing through, but no solids.

Filtration. Straining; the act of passing through a filter; the separation of liquids from substances mechanically suspended in them.

Filtering Apparatus. A is a piece of wood 1 inch, sawed out half the circumference of the demijohn B. D is a soft wire to hook into the screw E. The whole may be fastened to the wall or elsewhere at proper height. Provide B with a cork, through which passes a glass tube 3 or 4 inches long. Cut the cork as represented at F. The demijohn with

FIG. 97.



the solution is inverted over a funnel containing the filter. The uprights H H support the piece G and keep the demijohn from resting on the funnel. The funnel is supported by the shelf I, which in turn rests on the brackets J J, fastened to the wall or elsewhere.

Fig. 98 is a filtering apparatus devised by Rev. Dr. Clarence A. Woodman, and designed to keep the filter full during the operation. Place the bottle on a shelf or stand, above the level of the filter. The tube *b* should dip far enough down into the liquid to draw off the amount wished. The other end should descend deeply into the filter. The tube *a* at one end reaches just below the mouth of the bottle, the other end being fixed at the height in the bottle at which you wish to keep the solution. Start the apparatus by sucking the liquid into the tube *b*. It will flow steadily until it reaches and so closes the lower end of the tube *a*, for, by cutting off the ingress of air into the bottle, it stops any further flow till the liquid in the filter again sinks below the end of *a*. The minute *a* is clear, the flow will again commence, to stop as before, when *a* is covered. When the liquid in the bottle sinks below the end of *b*, the whole operation ceases.

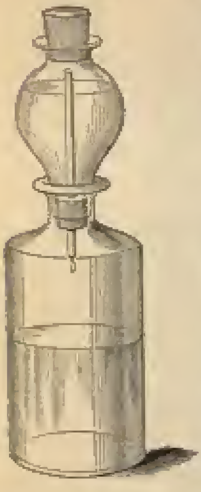
FIG. 98.

Filtering-Paper. Unsized, porous paper. In making a paper filter, take a piece of the paper of a size proportionate to that of your funnel, and first double it from corner to corner in the form of a triangle, which is again doubled into a smaller triangle, and round off the angular portion of the margin with a pair of scissors; this forms a cone the apex of which is placed downward in the funnel. Another method is to double the paper once, and then fold it in the same way you would a fan, observing so to open it and lay it on the funnel that a sufficient interval be left between the two to permit of the free percolation of the liquid.

Filtering Gelatinous Liquids. The filtration of collodion, gelatine solutions, and varnishes is quite difficult, owing to the rapid evaporation of the solvents. Several methods have been devised to facilitate the operation. For solutions of gelatine, gum-arabic, etc., the following may be adopted: A cylindrical vessel, of block tin, is made of sufficient capacity to hold 5 or 6 ounces of water, and to admit of a vessel being suspended above the surface of this in the interior—the height altogether must be sufficient to admit the funnel. The water is

brought to the boiling-point, and the steam, which fills the interior of the vessel, and of course surrounds the gelatinous solution, keeps it in a state of perfectly manageable liquidity as long as is required. A piece of sponge or tuft of cotton is lightly pressed into the neck of the funnel.

Fig. 99.



Filter for Collodion. Take a common glass chimney and invert it in a bottle. (See Fig. 99.) Cork up both ends of the chimney, cut a hole through the lower cork, and place therein a glass tube reaching from the bottle to the chimney. Cut a few slits in the same cork and wind clean cotton about it, when it is ready for use. Pour the collodion into the inverted chimney and let the operation of filtering take its course.

Finder. A small box, fitted with a lens and ground-glass, forming a miniature camera, attached to many hand-cameras, and used to secure a representation on a reduced scale of the view obtainable in the camera proper without recourse to the larger ground-glass screen of the camera. The ideal finder should be as nearly the size of the focussing screen of the camera proper as is possible, and should be well sunken below the surface of the camera box to avoid reflection, which would prevent the discernment of the image. The ordinary finder is generally so small as to be of little use save as a guide in composing and selecting the objects to be included.

Finger-Prints. Francis Galton suggests that if the tip of the finger or the thumb is smeared on a pad holding printer's ink, carefully impressed upon paper, and enlarged by photography, a ready means of identification is gained, useful for passports, etc.

Fixation. The act of fixing; stability; firmness.

Fixed. Made permanent. A photograph is said to be "fixed" after having been submitted to the "fixing bath" and well washed. (See *Fading.*)

Fixing. The name given to the opreation of removing from the films of negatives or positives the sensitive salt unaffected by light or development. This operation, which renders the image permanent or further unalterable by light action, should properly be termed clearing. In the wet collodion process, cyanide of potassium was used for this purpose; for gelatine dry plates, albumen and chloride prints, etc., hyposulphite (or thiosulphate) of soda is used. Among the other substances suggested are ammonium hyposulphite, sodium sulphite, etc.; hypo soda, however, is generally used. In printing on plain paper ammonia is advised as an excellent fixing agent. For fixing gelatine negatives the bath usually employed is composed of 4 parts of water and 1 part hypo soda. For albumen prints the proportion should be 1 to 5; for chloride emulsion prints a weaker solution of 1 part of hypo-soda to 10 or 20 parts of water is recommended on account of the extreme delicacy of the image in this process. By some workers an acid fixing bath for negatives is thought to possess certain advantages, while others have claimed that the addition of alum to the bath gives clearness and a tough film.

Fixing, Theory of. The last process but one in photographic manipulation. The agents for this purpose are various, but cyanide of potassium and hyposulphite of soda are now universally employed in preference to all others, and in a majority of cases the latter only is used. Ammonia is a good fixing agent for paper prints, but is seldom used. A sensitive layer of chloride or iodide of silver, on which an image has been formed, either with or without the aid of a developing agent, must pass through this process in order to render it indestructible by diffused light. It is true that the image itself is sufficiently permanent, and cannot be said, in corect language, to need fixing; but the unchanged silver salt which surrounds it, being still sensitive to light, tends to be decomposed in its turn, and so the picture is lost. It is, therefore, necessary to remove this salt by applying some chemical agent capable of dissolving it. In order that any body may be employed with success as a fixing agent, it is required not only that it should dissolve unchanged chloride or iodide of silver, but that it should produce no injurious effect upon the same salt reduced by light. This solvent action upon the image,

as well as upon the parts that surround it, is most liable to happen when the agency of light alone, without a developer, has been employed. In that case the darkened surface, not being perfectly reduced to the metallic state, remains soluble to a certain extent in the fixing liquid. Solution of *cyanide of potassium* is a most energetic agent in dissolving the insoluble silver salt; far more so, in proportion to the quantity used, than the hyposulphite of soda. The salts are in all cases converted into cyanides, and exist in the solution in the form of soluble double salts, which, unlike the double iodides, are not affected by dilution with water. Cyanide of potassium is unadapted for fixing positive proofs upon chloride of silver; and even when a developer has been used, unless the solution is tolerably dilute, it is apt to attack the image and dissolve it. It is very little used on account of its poisonous nature. *Hyposulphite of soda* is employed not only on account of its greater safety, but because it is more economical. The fact that the silver contained in an ordinary fixing bath is present in the state of hyposulphite must be borne in mind, because this salt is liable to undergo peculiar chemical changes. Iodide of silver is dissolved by hyposulphite of soda more slowly than chloride of silver, and the amount eventually taken up is less. This is explained by stating that during the solution of iodide of silver, iodide of sodium is formed; and this alkaline iodide has a prejudicial effect upon the continuance of the process. Chloride of sodium has not the same action, neither has bromide of sodium, consequently the corresponding silver salts dissolve to a greater extent than the iodides. *Ammonia*, although a good fixing agent for paper proofs, is little used on account of some slight difficulties in its action. It dissolves chloride of silver readily, but not iodide of silver; hence its use is confined to the paper prints. Even these cannot be advantageously fixed in ammonia unless a deposit of gold has been previously produced by the toning process. A peculiar and unpleasant red tint is always caused by ammonia acting upon the darkened material of the sun picture as it comes from the printing-frame; but this is obviated by the employment of the gold. With ammonia the best proportions for the bath are 10 drops aqua ammoniæ to 1 pint of pure water.

Fixing Ambrotypes. Either solution of cyanide of potassium or of hyposulphite of soda may be used for this purpose. The formulæ are as follows:

A.	Hyposulphite of Soda	4 ounces.
	Water	1 pint.
B.	Cyanide of Potassium	½ ounce.
	Water	1 pint.

Filter after solution. Some operators add a little chloride of silver. The solution may be poured over the plate, or the plate may be immersed in the solution. If the latter method is employed the solution must be repeatedly filtered; and when it becomes too weak fresh must be made. (See *Ambrotype*.)

Fixing and Toning Bath. A bath in which the fixing and toning substances are combined. The formulæ for these baths are very numerous; many of them will be found under various headings.

Fixing Bath. Aqueous solution of hyposulphite of soda used for fixing (*q. v.*) developed negatives and toned paper prints in the proportion of 25 hypo to 100 water for negatives, and 20 hypo to 100 water for prints.

Fixing Daguerrotypes. Make a solution of hyposulphite of soda in distilled water, one-half ounce of the salt to one pint water, and filter. Hold the plate in the left hand with your pliers by one corner—which must be previously bent up so that the solution will not come in contact with the iron—and flood the plate with the fixing solution, agitating it at the same time; allow it to remain until all the unchanged iodide of silver is washed off (if the first application is insufficient renew the solution); then wash thoroughly with distilled water, being careful to remove every particle of dust, and dry it.

Fixing Negatives on Glass. This operation is conducted in precisely the same manner and with the same solutions as for the ambrotype. (See *Ambrotype*.)

Fixing Negatives on Paper. Bromide of potassium and hyposulphite of soda are the principal agents for fixing paper negatives. The methods are various and are described under the different processes given in this work. (See *Calotype*, *Wax-Paper Process*, etc.)

Fixing Paper Proofs. This is one of the most important branches of the photographic art, and on it depends not only the permanence of the print, but the future success and greatness of photography as an art. There

are two methods of accomplishing this: 1st, with the fixing and toning bath combined, and 2d, toning first and fixing afterward. Fixing and toning positive prints are so intimately connected that the manipulatory details are given under *Fixing the Print;* The conditions necessary for the proper fixing of the proof are not always understood by operators, and consequently they have no certain guide as to how long the print should remain in the fixing bath. The time occupied in fixing will, of course, vary with the strength of the solution employed; but there are simple rules which may be usefully followed. In the act of dissolving the unaltered chloride of silver in the proof, the fixing solution of hyposulphite of soda converts it into hyposulphite of silver, which is soluble in an excess of hyposulphite of soda. But if there be an insufficient excess—that is, if the bath be too weak or the print removed from it too speedily—then the hyposulphite of silver is not perfectly dissolved, and begins by degrees to decompose, producing a brown deposit in the tissue of the paper. This deposit, which has the appearance of yellow spots and patches, is not usually seen upon the surface of the print, but becomes very evident when held up to the light, or if it be split in half, which can be readily done by gluing it between two flat surfaces of deal, and then forcing them asunder. In order to understand more fully how decomposition of hyposulphite of silver may affect the process of fixing, the peculiar properties of this salt should be studied. With this view nitrate of silver and hyposulphite of soda may be mixed in equivalent proportions, viz., about twenty-one grains of the former to sixteen grains of the latter, first dissolving each in separate vessels in half an ounce of distilled water. These solutions are to be poured together and well agitated; immediately a dense deposit forms, which is hyposulphite of silver. At this point a curious series of changes commences. The precipitate, at first white and curdy, soon alters in color; it becomes canary-yellow, then of a rich orange-yellow, afterward liver-color, and finally black. The *rationale* of these changes is explained to a certain extent by studying the composition of the hyposulphite of silver. The formula for this substance is: $AgOS_2O_2$. But $AgO S_2O_2$ plainly equals AgS, or sulphuret of silver, and SO_3, or sulphuric acid. The acid reaction assumed by the supernatant liquid is due therefore to sulphuric acid, and the black substance formed is sulphuret of silver. The yellow and orange-yellow compounds appear in earlier stages of the decomposition; their nature is uncertain. The instability of hyposulphite of silver is principally seen when it is in an isolated state; the presence of an excess of hyposulphite of soda renders it more permanent by forming a double salt. In fixing photographic prints this brown deposit of hyposulphite of silver is very liable to form in the bath and upon the picture, particularly so when the *temperature* is high. To obviate it observe the following directions: It is especially in the reaction between the nitrate of silver and hyposulphite of soda that the blackening is seen; the chloride and other *insoluble* salts of silver being dissolved, even to saturation, without any decomposition of the hyposulphite formed. Hence if the print be washed in water to remove the soluble nitrate a very much weaker fixing bath than usual may be employed. But if the proofs are taken at once from the printing-frame and immersed in a dilute bath of hyposulphite (one part of the salt to six or eight of water), a *shade of brown* may be often observed to pass over the surface of the print, and a large deposit of sulphuret of silver soon forms as the result of the decomposition. On the other hand, with a strong hyposulphite bath there is little or no discoloration, and the black deposit is absent. The print must also be left for a sufficient time in the fixing bath, or some appearance of brown patches, visible by transmitted light, may occur. Each atom of nitrate of silver requires *three* atoms of hyposulphite of soda to form the *sweet* and *soluble double salt*, and hence, if the action be not continued sufficiently long, another compound will be formed, almost tasteless and insoluble. Even immersion in a new bath of hyposulphite of soda does not fix the print when once the yellow salt is insoluble in hyposulphite of soda, and consequently remains in the paper. In fixing prints by ammonia the same rule may be applied as in the case of hyposulphite of soda, viz., that if the process be not properly performed the white parts of the print will appear *spotted* when held up to the light from a portion of insoluble silver salt remaining in the paper. Prints

imperfectly fixed by ammonia are also usually brown and discolored on the surface of the paper. *Albumenized* paper, from the horny nature of its surface-coating, requires longer treatment with the hyposulphite than plain paper. There is every reason to think that the photographic image, however formed, is permanent if certain injurious conditions are avoided; in other words, that prints do not *necessarily fade* in the same manner as fugitive colors by simple exposure to light and air. But supposing a case, which is the common one, of injurious influences which cannot be removed, it may be useful to inquire what mode of printing gives the greatest amount of stability. (See *Photographic Printing*.)—*Hardwich.*

Fixing Solutions. Solutions of such substances as tend to dissolve out unchanged iodide and chloride of silver from the photographic picture, and thus preventing further darkening of the impression by light.

Flange. A sliding tube; a tube-like projection on the objective, designed to hold the cap and to exclude side and direct sunlight.

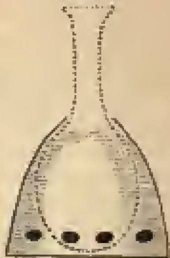
Flashing (Flashy). Breaking forth suddenly. In daguerrotyping a term applied to a rapid volatilization of the accelerating substance. It is caused by an excess of bromine, or too high temperature.

Flash-light Photography. In photography by artificial light, magnesium powder, aluminium powdered, and various compounds of these with other substances, producing a flash-light of great intensity, are chiefly used. Of those mentioned, pure magnesium powder, or ribbon, is perhaps the best and least dangerous in manipulation. Flash-light compounds are used principally for interior work, and photographing at night, in caves, etc., and for the recording of phenomena occurring where daylight is unavailable. Many flash-light mixtures, such as those containing chlorates, perchlorates, picric acid or a picrate, potassium bichromate, etc., are explosive, and require great care in handling. In Berlin there is established a portrait studio where the magnesium light is used exclusively. (See *Aluminium.*)

Flask. A glass vessel for heating or mixing liquid preparations; used in the laboratory, dark-room, etc. Flasks which are conical in shape are preferable for ordinary use. Graduated flasks are obtainable, on the outside of which various measures are marked by a ring etched in the glass.

Flask for Cooking Emulsion. The sketch explains the device. It consists merely of a collar formed from a piece of sheet lead, bent to the proper shape of, and maybe a half-inch deeper than, the glass flask, and also pierced with several holes, to allow the water to flow through it easily when placed in boiling water. The collar prevents the flask from turning over.

FIG. 100.



Flatness of Field. The property of a photographic objective of rendering the lines of the middle of the picture, as well as those at the edges, according to the rules of perspective, and at the same time of even sharpness.

Flat or Thin Negative. Negatives which from over-exposure and insufficient development fail to attain the necessary degree of density, and give flat pictures, deficient in contrast, unless first strengthened.

Flat Picture. A picture which from false illumination (for instance, in a view when the sun is directly behind the camera) shows no contrast—is monotonous.

Flint Glass. A glass made of fossil meal, potash, calcium, and oxide of lead. Differs from crown glass (*q. v.*) by its containing oxide of lead, which gives it greater density, greater refrangibility, also making it more easily fusible. Crown glass united with it serves to achromatize it, as in a lens.

Floating. Lying flat on the surface of a liquid. In photography in many processes the papers are floated upon the sensitive solutions instead of the latter being brushed over. In every instance, no matter what its nature, this operation must be performed with care. A flat dish should be provided (and kept perfectly clean for each kind of solution), an inch or two larger each way than the size of the sheet to be floated; and before the paper is laid upon the solution the two corners diagonally opposite should be bent over upon the back of the paper by which to handle the sheet. These corners must be kept dry.

Fluate of Soda. This salt is composed of 1 part of fluorine and 1 of sodium. It has been used in many different ways, and variously combined. It has been found to have the property of quickening the sensibility of

bromidated paper to a very remarkable extent. (See *Fluorotype.*)

Fluid. A body whose particles move easily among themselves, and yield to the least force impressed, and which, when that force is removed, recovers its previous state. Fluid is a generic term comprehending liquids and gases.

Fluidity. The quality of being capable of flowing; a liquid or gaseous state. Fluidity is the effect of heat.

Fluorates. Compounds of fluoric acid with the bases. The *fluorates of potassium and soda* have been used in many different manners, and variously combined, and are found to quicken the sensitiveness of bromidated papers to a very remarkable extent. (See *Fluorotype.*)

Fluo-Bromide of Lime. One of the accelerators for the daguerrotype plate. 1 or 2 drops of fluoric acid to the ounce of *bromide* of lime, changes it into this compound. But fluoric acid is a dangerous poison, and the "quick" made from it will not repay the risk to the health in using it: it has besides a destructive effects upon the lenses.

Fluoreal. An alkaline developer, by G. Mercier, of Paris, containing carbonate of lithium (alkali), and also a yellow coloring matter, fluoresceïn, which prevents fog during development by absorbing the actinic rays; is very energetic, giving strong negatives full of detail.

Fluorescence. A term denoting the property possessed by many solids and liquids of changing invisible actinic rays of high refrangibility into visible rays of low refrangibility.

Fluorescent. The effect produced on light by some solid and liquid surfaces. This effect is supposed to have considerable importance in photography.

Fluorescent Surfaces. Surfaces upon which, or by which, fluorescence is produced.

Fluoric Acid. (See *Hydrofluoric Acid.*)

Fluoride. A compound of fluorine with a base.

Fluoride of Ammonium. Combined with iodide of potassium this gives great sensibility to photographic papers; this is due to the reducing action of the hydrogen, which enters largely into its composition, and to that of fluorine. Yet, although it gives greater sensitiveness the fluoride of potassium is preferable, as it has more stability. It is also necessary, in order to obtain constancy in the result, to operate while it is in a nascent state.

Fluoride of Bromine. A union of 2 parts of fluorine and 1 of bromine. It is formed in the preparation of the solution for the fluorotype, and in that of the fluo-bromide of lime for the daguerrotype.

Fluoride of Lithium. A salt formed by the union of hydrofluoric acid and lithium; it may be obtained by a process identical with that by which fluoride of sodium and potassium are made.

Fluoride of Potassium. A deliquescent salt, occurring in small imperfect crystals; very soluble in water, the solution acting upon glass in the same manner as hydrofluoric acid. In conjunction with papers prepared with the iodides this gives great sensibility, owing, probably, to the repulsive force between oxygen and fluoric gas. (See *Fluorotype.*)

Fluoride of Silver. This salt is obtained by dissolving carbonate of silver in hydrofluoric acid. It is, as yet, but little studied, but it may serve for making negative proofs. The agents for developing the image are nitrate of silver, chloride of gold, and protosulphate of iron. (See *Fluorotype.*)

Fluoride of Sodium. A salt formed by the union of 16 equivalents of fluorine and 24 equivalents of sodium, and may be obtained by the same process as for the fluoride of potassium. The addition of fluoride of sodium to the iodide or chloride of silver, in the first preparation of paper, gives considerable accelerating power.

Fluorography. A process by which photographic pictures are transferred upon glass with the aid of flux colors. When these colors come in contact with sulphuric acid, hydrofluoric acid is generated, which attacks the parts of the glass not covered by the color, thus etching the picture (matt) into the glass.

Fluorography. Fluorography is a process of transferring lithographic or phototypic prints to glass by means of fluorated ink, which, in contact with sulphuric acid, disengages hydrofluoric acid, which eats into the glass. The phototype is inked with the following compound:

Soap	50	grammes.
Glycerine	200	"
Tallow	50	"
Water	100	"
Borax	25	"
Fluorspar	50	"
Lampblack	15	"

Negatives are taken and transferred to the glass. The latter is surrounded with a border of wax and covered with sulphuric acid of a density of 64° or 65° Beaumé. After fifteen or twenty minutes the acid is poured off and the glass is washed with water and cleaned with a solution of potassa, then washed with water again, and dried with a cloth.

Fluorotype. So called from the introduction of the salts of fluoric acid; it consists of the following process of manipulation:

1.	Distilled Water . . .	1 fluidounce.
	Bromide of Potassium .	20 grains.
2.	Fluoride of Sodium . .	5 grains.
	Distilled Water . . .	1 fluidounce.

Mix a small quantity of these solutions together when the papers are to be prepared, and wash them once over with the mixture, and, when dry, apply a solution of nitrate of silver, 60 grains to the ounce of water. These papers keep for some weeks without injury, and become impressed with good images in half a minute in the camera. The impression is not sufficiently strong when removed from the camera for producing positive pictures, but may be rendered so by a secondary process.

The photograph should first be soaked in water for a few minutes, and then placed upon a slab of porcelain, and a weak solution of the protosulphate of iron brushed over it; the picture almost immediately acquires an intense color, which should then be stopped directly by plunging it into water *slightly* acidulated with muriatic acid, or the blackening will extend all over the paper. It may be fixed by being soaked in water, and then dipped into a solution of hyposulphite of soda, and again soaked in water as in the other processes.

Mr. Bingham has the following remarks on this process, and he gives a modified form into which a new photographic element is introduced:

"We find it is better to add to the protosulphate of iron a little acetic or sulphuric acid; this will be found to prevent the darkening of the lights of the picture to a great extent, and it will be found better not to prepare the paper long before it is required for use, this being one reason why the picture often becomes dusky on application of the protosulphate.

"Reasoning upon the principle that the action of light is to reduce the salts of silver in the paper to the metallic state, and that any substance which would reduce silver would also quicken the action of light, we were led to the following experiment: The protochloride of tin possesses the property of reducing the salts both of silver and of gold; a paper was prepared with the bromide of silver, and previously to exposing it to light it was washed over with a very weak solution of the chloride of tin; the action of light upon the paper was exceedingly energetic; it was almost instantaneously blackened, and a copy of a print was obtained in a few seconds."

Flux. Easily fused glass (flint glass is best), which is mixed with the usual metallic oxide colors; used in enamelling or burning-in processes, to make them more fusible.

Focal Distance. The distance between the centre of a convex lens or concave mirror and its focus, or the points into which the rays of light are collected. (See *Object Glasses.*)

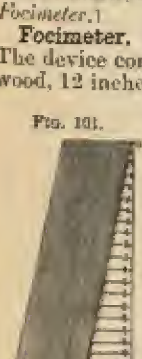
Focal Length. The distance of the focus from the lens upon which fall the rays parallel with the lens axis.

Foci. The plural of *focus.* The foci of a photographic lens are actinic or chemical, and luminous or visual; they are also conjugate. (See *Conjugate Foci.*) The same causes which produce chromatic aberration (see *Chromatic Aberration*) in a lens, tend also to separate the chemical from the visual focus. The violet and indigo rays are more strongly bent-in than the yellow, and still more than the red; consequently the focus for each of these colors is at a different point. Non-achromatic lenses are understood by all to require correction for the chemical focus; but it is usually said of the compound lenses, that their two foci correspond. If in either case the foci do not correspond, proceed as follows to find the variation for correction: First, ascertain that the prepared sensitive plate falls precisely in the place occupied by the ground-glass. Suspend a newspaper or a small engraving at the distance of about 3 feet from the camera, and focus the letters occupying the centre of the field; then insert the slide, with a square of *ground-glass* substituted for the ordinary plate (the rough surface of the glass looking inward), and observe if the letters are still distinct. If the result of this trial seems to show that the camera is good, proceed to test the correctness of the lens. Take a positive photograph with the

full aperture of the portrait lens, the central letters of the newspaper being carefully focussed as before. Then examine at what part of the plate the greatest amount of distinctness of outline is to be found. It will sometimes happen that, whereas the exact centre was focussed visually, the letters on a spot midway between the centre and edge are the sharpest in the photograph. In that case the chemical focus is longer than the other, and by a distance equivalent to, but in the opposite direction of, the space which the ground-glass has to be moved in order to define those particularly sharp to the eye. When the chemical focus is the shorter of the two, the letters in the photograph are indistinct at *every* portion of the plate; the experiment must, therefore, be repeated, the lens being shifted an eighth of an inch or less. Indeed, it will be proper to take many photographs at minute variations of focal distance before the capabilities of the lens will be fully shown. The object of finding the point at which the sharpest image is obtained will also be assisted by placing several small figures in different planes and focussing those in the centre. This being done, if the more distant figures come out distinctly in the photograph, the chemical focus is *longer* than the *visual*, or *vice versa* when the nearest ones are more sharply defined. When once the variation is found it can be marked upon the camera tube. (See *Focimeter*.)

Focimeter. Invention of Dr. O. G. Mason. The device consists of a rectangular piece of wood, 12 inches long, 2 inches thick at base, and tapering on one side to nothing at the top, and 3 inches wide. On the edge is drawn a scale of lines one-half inch apart, at right angles with the perpendicular or back side. The zero of the scale is placed on the centre line, from which the numbers run away. The base of the block is of such thickness that the line of the acute angle or foci side will intersect each succeeding line of the scale one-tenth of an inch nearer to or farther from the perpendicular back, than the next preceding line up or down. Upon this foci or sloping side is placed a piece of finely printed matter. By placing the focimeter before the camera to be tested, and focussing some portion of the surface upon the ground-glass, observing which line of the scale is coincident with that portion of the foci best defined, the resulting negative will show whether the chemical and visual foci are the same. For example, you focus on number five below zero, and your negative shows best definition at two above zero. You thus find that your lens has a chemical focus of five-tenths of an inch longer than its visual focus; thus you know ever after just how much to correct your camera—a point of the greatest value to every photographer.

FIG. 161.



Focus. The point at which any number of rays meet after being reflected or refracted; the point beyond the convex lens where the refracted rays meet. This point depends upon the form of the lens and the refracting power of the substance of which it is composed. The less convex or bulging the lens is, the more distant is its focus; the more convex the lens is, the more obliquely will the rays fall upon the surface, and the sooner—in consequence of their being more bent—will they meet.

Focussing. The moving of the ground-glass of the camera or of the objective till the optical picture on the ground-glass shows sharp in all its parts.

Focussing-Cloth. A light-tight cloth which the photographer uses over his head when focussing, thus excluding the light from the ground-glass.

Focussing-Glass. A magnifying glass which, in focussing, is placed upon the ground-glass, rendering the details in the optical picture more distinct, thus facilitating focussing.

Focussing-Screen. This is a sheet of ground-glass exactly the size of the picture, and fixed in a frame. Its use is to enable the photographer to adjust the size and focus of the object to be photographed. For this purpose it is inserted in the camera in the same groove which is to receive the dark-slide subsequently, and with its ground surface next to the lens. It is important that the ground side of this screen should really occupy the same position with respect to the lens that the sensitive surface afterward does; for if it should not, all the focussing upon it will be erroneous and the photographs will be deficient in sharpness.

Focussing-Screw. A screw attached to

the objective, by which the lens-combination or system can be moved backward or forward, regulating the focus.

Focussing-Tube. This is an apparatus intended to take the place of the focussing-cloth. It consists of a square tube of black pasteboard, made to fold in the same way as the common folding camera, the joints being formed of black ribbon. A light frame with a flange is hinged in the same way to the top of the tube, and when let down fits into the end and keeps the tube extended; the outside of this frame is covered with black velvet, which serves to exclude the light when pressed against the ground-glass.

Fog. Often observable in gelatine negatives in the form of a veil (colored or otherwise) over the entire negative. There are two kinds of fog: chemical and light-fog. Chemical fog is due either to error in the preparation of the emulsion with which the plate is coated, or to the use of an excessive amount of alkali in development; light-fog may be caused by the access of light to the plate before or during exposure or development. To clear fogged negatives a mixture of glycerine and water in equal parts, to which from 45 to 50 parts of a cold, saturated solution of hypo soda has been added, should be spread over the surface of the fogged plate, and allowed to remain thereon, protected from heat and dust, until the negative is cleared, when it is well washed.

Fogging. A state of the albumen, collodion or other glass photograph in which the image appears indistinct, hazy, or of one uniform dim-grayish color, by transmitted light; want of clearness; a dimness in the lights and shadows. The causes of fogging are several. Impure acetic acid, or protosulphate of iron in the developer, will often cause fogging when other things are right. Impurities of the other chemicals will also cause fogging; alkalinity or impurity of the nitrate bath, and irregularity in the action of light are frequent causes. Strongly fused nitrate of silver contains oxide and nitrite of silver, both of which produce fogging. As a remedy add acetic acid, one drop to the ounce of the nitrate bath. An alkaline collodion may be used with an acid bath, but if the bath is neutral it will cause fogging. Decomposition of the bath by light, or by long keeping; omission of the acetic acid in the pyrogallic solution; accidental introduction of pyrogallic acid into the collodion; use of water containing carbonate of lime; partial decomposition of the nitrate bath by the introduction of iron, hyposulphite of soda, or any developing agent, even in minute quantity, also by the use of accelerators which injure the bath by degrees, and eventually prevent its employment in a neutral state; vapor of ammonia, or hydrosulphate of ammonia, escaping into the developing-room; immersing the plate in the developer when the film is neutral, and re-dipping the plate in the nitrate bath before development—all produce fogging to a greater or less extent. Fogging is caused by light, by over-exposure in the camera; by diffused light in the developing-room; by diffused light in the camera; by direct rays of the sun falling upon the lens, and by diffused light of the sky falling upon the lens. The statement of the causes of fogging suggest the remedy for each; but the difficulty of ascertaining the specific cause of its occurrence suggests rules of proceeding to detect the nature of the case and provide the remedy. If the fogging is caused by *over-exposure*, a faint image first appears, and is followed by a general cloudiness when the developer is poured on. Having obviated this, proceed to test the bath—if further fogging occurs; if it is made from pure materials and does not restore the blue color of litmus-paper previously reddened by holding it over acetic acid, it may be considered in working order. Next prepare a sensitive plate, and after draining it for two or three minutes in a dark place, pour on the developer; wash, fix, and bring out to the light; if any mistiness is perceptible, either the developing-room is not sufficiently dark, or the bath was prepared with impure nitrate of silver, or water. If the plate remains absolutely clear under these circumstances, the cause may be in the camera; therefore prepare another sensitive film, place it in the camera, and proceed exactly as if taking a picture, with the exception of not removing the brass cap of the lens; allow it to remain two or three minutes, and then remove and develop as usual. If no indication of the cause of fogging is obtained in either of these ways, there is every reason to suppose that it is due to diffused light gaining entrance through the lens. This cause may be detected by looking into the camera from the front, when an irregular reflection will be seen upon the glass. If none of these causes are indicated then the

developer is at fault. It is either made of impure materials or it is too strong or too weak, and the quantities must be increased or diminished according to circumstances; and if the difficulty is not then obviated fresh material must be procured. The other causes of fogging enumerated need never occur to a careful operator and can only be prevented by keeping the obnoxious chemicals out of harm's way.

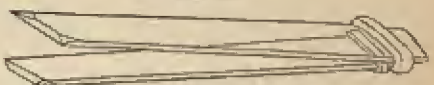
Foggy Spots. Light, misty spots frequently occurring in the centre of the sensitive film after exposure and development, when a very small aperture is used between the lenses. Various causes have been assigned for this imperfection, but the reason given by Mr. Brackenridge seems to be the true one. He says: The explanation which has always seemed to me to be the most plausible, was suggested by observing that when the light is passed through a small aperture into a darkened room, the minute particles which are always floating in the atmosphere become brilliantly illuminated where the rays are concentrated upon them; as the aperture is enlarged, the light becomes more diffused, and these floating atoms less and less visible, until in the full light of the window they are entirely lost. Now, why may not this spot be caused by an image of these particles passing through the small hole of the diaphragm? It is evident that the spot is the image of something, and it cannot be the image of a solid opaque body, or the details of the picture could not be seen through it; but these floating atoms, although opaque enough to reflect light, are yet as a mass sufficiently translucent to permit the refracted image of the view to pass through them and become impressed upon the plate. This would account for the centre of the picture presenting the appearance of being covered with a veil of light, or being fogged at that point. As the diaphragm is enlarged, the light in the centre of the plate becomes more diffused until with a full aperture it is scarcely noticed, precisely the same thing taking place as with the light from an aperture in the shutter of a window; while on the other hand, if the diaphragm is reduced in size, the light at last becomes entirely concentrated upon the particles suspended in the atmosphere, which are opposite the small opening, the light reflected from them being sufficient to produce an image which entirely obliterates the picture at that point, leaving a white spot a little larger than the hole in the diaphragm. This theory is further supported by the fact that when the diaphragm is placed *in front* of the lens the foggy spots can scarcely be distinguished; the reason being that when the diaphragm was *between* the lenses, the front lens acted as a condenser, concentrating the light which passes through the aperture, and, of course, illuminating the floating particles more powerfully. Also called a "ghost" and "flaw-spots."

Folding Background. A background capable of being folded into a small compass.

Folding Camera. A camera made so as to fold up and pack into a small compass. There are several styles of this camera; among them, and probably the most useful, is the bellows box, so made that the bellows folds into the woodwork as the front and back of the box are pushed together.

Forceps. Used by printers and others to prevent contamination of the prints. They can be easily and cheaply constructed, as follows: Take two equal strips of ordinary

FIG. 102.



sheet-glass; these may be four inches long and half an inch broad. The sharp edges must first be taken off, then place the strips together and crowd a piece of rubber tube, about half an inch long, over the two at one end. Next slide a shorter piece of tube down the length of one of the pieces of glass, until it reaches the first piece of rubber. The second rubber band serves to keep the two blades separate, while the elasticity of the first makes resistance as the blades are pressed together by the hand in grasping an object. When this pressure is removed they will separate half an inch at the end. It is best to bring the lower ends of the glass strips to an edge, or to bevel off the corners on a grindstone, so that they will readily slide under a sheet of paper which lies on the bottom of a dish. Broad blades are advantageous when lifting large sheets of paper liable to tear. A pair one inch by seven will be found quite convenient.

Foreshorten. To represent figures as they appear to the eye when seen obliquely.

Foreshortening. The representation or appearance of figures when viewed obliquely.

Form. The shape or external appearance of a body; the figure as defined by lines and angles; that manner of being, peculiar to each body, which exhibits it to the eye as distinct from every other body. Model; likeness; image.

Formic Acid. A natural product obtained by infusing ants in a small quantity of water, and submitting them to the action of heat in a retort; the formic acid distils over, and may be condensed in a cooled receiver. It is a solid uncrystallizable substance; specific gravity, 1.1168. Its constituents are: carbon, 12; hydrogen, 1; oxygen, 24, and its equivalent number, 37. It serves to increase the developing or reducing power of the iron developer.

Formic Acid Developer. This developer is said to bring out the details of a picture much finer than any other.

Formula. A prescribed form; a rule or model; a term applied to the symbols representing the different substances.

Fossil Powder. Bone ashes; calcined cuttle-fish reduced to powder. Formerly used as a drying powder in the daguerrean process. Similar to rottenstone for polishing glass.

Fothergill Dry Process. A collodio-albumen process introduced by Mr. Fothergill, as its name implies. The mechanical manipulations are the same as for the ordinary collodion processes. Coat your plate with a *sensitive* negative collodion, which has been prepared with gun-cotton, made with the acids at high temperature—old collodion will not do; sensitize in a bath of 35 grains nitrate of silver to the ounce of water; drain for one minute, and wash away the free nitrate by pouring *gently* over the plate some filtered rain-water, and moving it round and round the plate by direction of the hand. Do this four or five times until all greasiness has left the surface; let your plate stand cornerwise on clean blotting-paper for half a minute, and then pour on a coating of

White of Eggs (fresh)	10 drachms.
Distilled Water	6 "
Liquid Ammonia	8 minims.

previously filtered and allowed to re-liquefy by standing; no filtering required. Move this albumen coating round the plate for about a minute, and now *repeat the washing as before*, and dry. Carefully keep your plate in the dark. Develop with

Pyrogallic Acid	1½ to 2 grains.
Water	1 ounce.
Acetic Acid	10 minims.
Alcohol (pure)	5 "

being careful to add *first* two drops to a drachm of nitrate of silver solution, 35 grains to the ounce. Fix in hyposulphite of soda.

Frangible. Liable to be broken; easily broken.

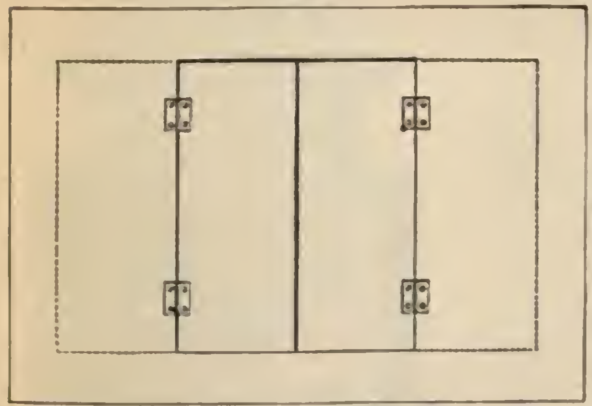
Frangibility. The state or quality of being frangible.

Fraunhofer's Lines. Amongst the most curious instances of the absorption of light is that which is uniformly observed in the solar spectrum, if we examine it with a telescope. We then find that the colored rays are crossed by a great number of dark bands or lines, giving no light of any color; these are generally called "Fraunhofer's lines," as to him their discovery, measurement, and enumeration are due. It is quite clear that these lines represent rays which have been absorbed by their passage from the sun to the earth; although some of them have no doubt undergone absorption within the limits of the earth's atmosphere.

Freak Photography. A method of making various positions of the same subject on the same plate. One way consists of a thin board set into the camera-box in front of the ground-glass, and is applicable to any size. The shutter should be enlarged as the size of the plate is increased. It permits one door to be at a slight angle when the other is fully open and an exposure is being made. After this exposure, the slide of the holder is inserted, the holder removed from the camera and arranged for the second, or No. 2, exposure. Then the door No. 1 is arranged at a slight angle, and No. 2 thrown open while the second exposure is made. There will not be any central line if all is done carefully. If a white central line does appear it indicates too much angle. The hinges should be rigid, so that the shutters will remain fixed at the proper angle. The engraving presents the shutter as seen when looking into the camera from the front toward the ground-glass. The second figure represents another way. The engraving represents the view camera at the back. The screen-board with the opening is fixed in front of the ground-glass. When No. 1 is being exposed,

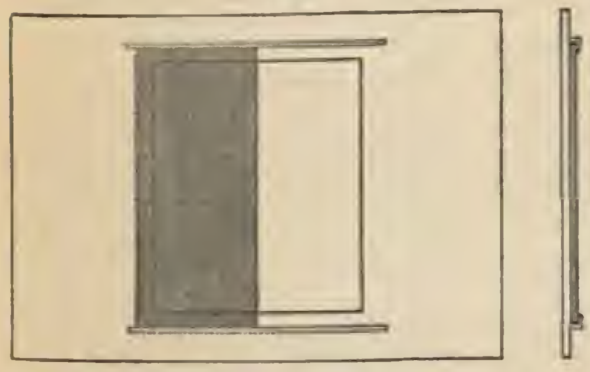
No. 2 is closed. The holder is withdrawn while the second exposure is arranged for, and No. 1 is closed. If a black line occurs upon the negative, the moving shutter in the fixed board was a little beyond the centre; if a white line is formed, then the moving shutter was too widely opened. Fair effects are had by cutting an aperture in the dark slide, reversing it in the holder as the first and second exposures were made.

FIG. 103.



Free. In photography, not chemically combined with any other body; at liberty to escape, as *free iodine* in the collodion, indicating an excess of iodine; or *free nitrate of silver* on the sensitized plate, which is unnecessary to the quality of the picture, and can be washed off before exposure, and is removed after exposure by the fixing bath. Silver unaffected by the light, on sensitive printing paper, and to be washed off previous to toning and fixing. Any substance added to another in such excess that a portion will not combine with the other; the *excess* is spoken of as being "free."

FIG. 104.



Free Revolver Stand. A stand invented by Prof. Piazzi Smyth, of Scotland, on the principle of the gyroscope, for the purpose of steadying the instrument and keeping it in the same plane on a moving body, such as a ship in a storm. A heavy wheel, with most of its weight situated toward the rim, as in a fly-wheel, is set spinning with a velocity of about 80 revolutions per second; and the frame supporting it is accurately balanced on gimbals, like a compass or chronometer. The spinner and its inner supporting frame (on which may be placed a small table) will now be found totally insensible to any movement which the outer frame may experience at right angles to the plane of rotation; and if this plane be in the first instance placed horizontally, such table will be then entirely defended from all the possible angular movements of a ship; and a telescope once directed on a star, will keep it within the field without hand, though the ship may pitch and roll and yaw to any extent.

Freezing Mixtures. When it is required to reduce the temperature of solutions in hot weather, this may be accomplished by standing the vessels containing the solutions in a pan containing a "freezing mixture." Such mixture may be compounded thus:

Ammonium Nitrate	1 part.
Water	1 "

or

Ammonium Nitrate	5 parts.
Potassium Nitrate	5 "
Water	16 "

Chloride of calcium may be used similarly for distillation at a low temperature and to accelerate the crystallization of salts.

Frilling. A defect observable in gelatine negatives or printing papers, caused by the

expansion of the film, and its consequent loosening from the support which holds it. As some plates and papers are more liable to frill than others, this fault may be due to some peculiarity in the emulsion used. Frilling is also more common in hot than in cold weather, and when excessive quantities of alkali are used in development with gelatine plates, or by the use of solutions which are too warm.

To prevent frilling in plates before development, a preliminary bath of alcohol is advised; or the plates may be protected with a narrow edging of India-rubber solution. Placing plates or gelatine paper in a bath composed of a 5 per cent. solution of chrome alum is also said to be efficacious. Of the commercial preparations obtainable for the prevention of this defect in plates or papers, Helmold's Fireproof (or Hardening) Mixture is excellent.

Fulminates. Compounds of fulminic acid with the bases. These compounds detonate or explode by percussion, friction, or heat, and therefore are dangerous to experiment with.

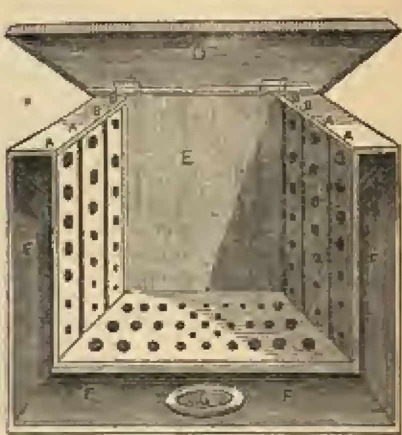
Fulminate of Silver. This is one of the fulminates which has been experimented with photographically, but it is so capricious in its results that no dependence can be placed on it. Mr. Hunt's experiments, however, have shown that this salt yields almost instantaneous intense black paper proofs under the action of light.

Fulminating Gold. Gold fulminate. $2NH_3AuO_3$. Yellow-brown precipitate, obtained by digesting freshly precipitated oxide of gold in ammonia. Very dangerous; explodes, when dry, by slightest friction. Used in preparing various salts of gold for gold toning baths.

Fuming (with ammonia). Treating albumen paper with the fumes of ammonia just before printing, which renders it more sensitive and easier to tone.

Fuming-Box. The front is omitted in the diagram (Fig. 105) to make the interior visible. This is the device of Mr. S. H. Parsons. A A B B are the grooves that the frames slide into. The box can be made to take any number of frames. One to fume six sheets at a time is a good size. Uneven fuming never occurs, and the paper works splendidly at all parts of the sheet. As soon as the paper is ready, take about one ounce of ammonia (which will fume enough for all day, and more) in a saucer, and put it in the chamber, having previously ascertained that the box is "closed;" put in the frames with the paper, shut down the top cover, and pull at the ring handles in front of the box. When fumed enough, push back the

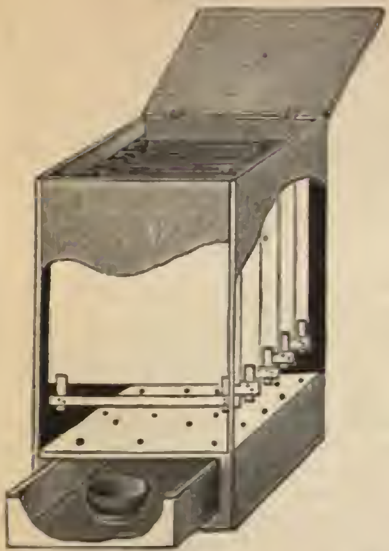
FIG. 105.



handles again, open the cover, and take out the paper. As the paper goes out, so will the small quantity of "exhausted" ammonia. In the meantime that in the chamber is gathering fresh strength from the saucer, and is fully charged for the next batch of paper.

Fuming-Cupboard. The construction is very simple. Take any common box large enough for the purpose, and make a door of suitable size, and which, when shut, totally excludes the light. Make a false bottom about six inches from the real one, and perforate it with holes with a large gimlet. These holes should be numerous. At the centre of the board there should be, if anything, a small number of them because the saucer containing the liquid ammonia is generally placed at the centre of the real box. The sheets should be suspended in this box by having a clip nailed at each end of a stick of sufficient length to be fastened at the top of the box parallel to the bottom. Several of these strips should be placed at about three inches apart. Thus quite a number of sheets may be fumed at once. (See Fig. 106.)

FIG. 106.



Funnel. A vessel for conveying fluids into close vessels; a kind of inverted hollow cone with a pipe. Used by photographers for supporting the filter. The glass funnel is the most cleanly, but those of gutta-percha are less liable to be broken, and therefore best for the travelling operator.

Fused. Melted; liquefied.

Fused Nitrate of Silver. The crystallized nitrate of silver may be easily fused in a porcelain capsule placed upon a sand-bath and heated by a lamp. During the operation it must be stirred with a glass rod, in order to prevent the portion in contact with the sides being over-heated. If the nitrate be impure, or contains organic matter, blackening will take place and *nitrite* of silver will be formed. While in the melted state nitrate of silver has a greenish-yellow color, but becomes nearly white on cooling. The aqueous solution restores the blue color of reddened litmus-paper; and this is probably the proper reaction of the pure salt, since it is invariably present, however carefully the process of fusing is performed. A photographic bath made from pure fused nitrate of silver will require no addition of carbonate of soda or of acetate of silver; simple solution in water, with iodide of silver to saturation, will be sufficient.

Fusion. In chemistry, the liquefaction of solid bodies by the action of heat. The term *aqueous fusion* is applied to the melting of salts in their combined water when heated, and *igneous fusion* to the liquefaction of bodies by heat alone. The *vessels* in which substances are fused are formed of various material and shapes, according to the properties of the solids operated on, and principally with reference to the heat required for its fusion. In every case the containing vessel should be capable of sustaining the proper degree of heat without melting or cracking, and should also resist the action of the substances melted in them.

Fuzzy Image. A picture which is not in focus; hazy and lacking sharpness.

G.

Gage's Positive Collodion Process. This process was introduced by Mr. F. B. Gage. The collodion is made of

Ether	4 ounces.
Alcohol, 95 per cent.	4 "
Iodide of Zinc	40 grains.
Bromide of Cadmium	30 "
Saturated Solution of Iodine	8 drops
Gun-cotton	28 to 30 grains.

It is important that the collodion be heavy enough to give a good film, but not containing so much cotton as to make it flow at all unevenly or be troublesome. The developer is made of

Protosulphate of Iron	3 ounces.
Water	1 quart.
Acetic Acid	6 to 8 ounces.

Mr. Gage's rules for developing are: 1. The stronger the developer the greater the contrast. 2. The weaker the developer the weaker the contrast. Therefore, if the first rule shows too strong contrast apply the second to your developing. As the light increases decrease the strength of the developing, and, *per contra*, if the light decreases increase the strength of the developing. Fix with cyanide of potassium or hyposulphite of soda, but the hypo is the best. If the latter is used, first put the developed picture in a weak solution of common salt.

Gallates. Salts formed of gallic acid with the bases.

Gallate of Lead. A salt formed by the union of gallic acid and lead, by pouring a

solution of gallic acid into another of acetate of lead, and washing the precipitate. The gallate of lead is a good developer for photographic prints upon chloride of silver enlarged in the solar camera: a cold saturated solution of gallic acid, to which is added some gallate of lead which is dissolved by boiling them together; then filtered, and when cold a few drops of acetic acid are added. The chlorided paper will require only a few seconds' exposure in the camera, as with iodized paper. The image develops quickly; the whites remain pure, while the blacks acquire great intensity. Tone with chloride of gold and fix as usual.

Gallery. The operating-room of the photographic artist.

Gallic Acid. This acid is made from gall-nuts, which are peculiar excrescences formed upon the branches and shoots of the *Quercus infectoria* by the puncture of a species of insect. It is produced by macerating five parts distilled water and one part pulverized gall-nuts for two or three months in a cellar at a temperature of 18° or 20°; it is then brought into the air and thoroughly dried. Afterward boil the mass in water or alcohol; filter while hot; the acid is extracted and on cooling crystallizes in long silky needles; soluble in 3 parts boiling and 100 parts cold water; also readily soluble in alcohol, but sparingly in ether. The flavor of gallic acid is acid and astringent, and it reddens litmus paper; it forms salts with the alkaline and earthy bases, but not with oxides of the noble metals. When added to oxide of silver the metal is separated and the oxygen absorbed. Aqueous solution of gallic acid becomes mouldy on keeping; this may be prevented by adding a drop or two of oil of cloves. Gallic acid is used in photography to develop negative and positive proofs, and restores the shades by its combination with the salts of silver which have lost their oxygen by the action of light. All the salts of silver which are in a sub-oxide or nearly metallic state are precipitated of a dark-brown color by this acid; thus proofs made upon the chloride, bromide, fluoride, cyanide, etc., may be used, as well as those made upon iodide of silver. It is used as a developer for partly printed chloride of silver pictures.

Gallo-Citrate of Iron. A salt formed by the union of gallic acid, citric acid, and iron; it may be made by mixing solutions of the first two with a solution of protosulphate of iron.

Gallo-Nitrate of Silver. A mixture of gallic acid and nitrate of silver in solution. Used principally in the calotype process for sensitive papers and in developers.

Galvanic Battery. An apparatus in which electricity is generated and evolved.

Galvanic Daguerrotypes. Facsimiles of daguerrotypes made by galvanoplasty.

Galvanizing. In photography, applied to the process of electro-silvering the daguerrotype plate.

Galvanoglyphy. The art of reproducing drawings by galvanism.

Galvanography. This process is similar to galvanoglyphy, electro-engraving, etc. (See *Photo-Galvanography* for its application to photography.)

Galvanoplastic (Galvanoplasty). Terms applied to galvanography, or the art of electrotyping.

Gamboge. A resinous gum of a beautiful deep-yellow color, soluble in water and used in the arts as a water or oil color.

Gas. A permanently elastic, aëriform fluid, or a substance reduced to the state of an aëriform fluid by its permanent combination with caloric. Gases are invisible except when colored, which happens in a few instances. Many of the gases are obnoxious to photographic operations, such as sulphuretted hydrogen, hydrochloric acid gas, etc.

Gas-Bag. A large India-rubber bag used by lanternists to hold the gases required for lantern exhibitions. Steel cylinders are now generally used in place of bags.

Gaslight in Photography. (See *Artificial Light.*)

Gelatine. One of the most important substances used in photography; is obtained chiefly from the bones and hides of oxen, and consists of two substances of indefinite composition—glutin and chondrin. That made from bones has a greater proportion of chondrin and is preferable for emulsion-making; the kind obtained from hides has a larger proportion of glutin, and is especially suited for carbon and photo-mechanical work. To distinguish these kinds make a saturated solution of chrome alum, and add to it an equal quantity of a 10 per cent. solution of the hot gelatine to be tested, when, if much chondrin is present, the hot gelatine solution will stiffen to a jelly in a few seconds.

Commercially, gelatine occurs in sheets or shreds of slightly yellow tint, the white variety made in France being obtained from fish bones. Good photographic gelatine should be almost colorless, should absorb six times its own volume of water at 15° C., and dissolve easily and completely at 30° to 40° C. When gelatine has been heated and cooled several times, or kept in a fluid state for some time, it loses its power of setting. The presence of an acid assists this peculiarity. To the photographer, gelatine is valuable because of its insolubility in cold water, its solubility in hot water; because it becomes insoluble after exposure to light, when mixed with substances such as potassium bichromate, and also because it becomes insoluble by the addition of such substances as chrome alum, without previous exposure to light. A rough test of the quality of gelatine may be made by fracture; the common kinds are brittle and short, the better sorts are tough and horny. For carbon and emulsion work, soft gelatines are used; while for photo-mechanical work a *hard* gelatine is preferable.

Gelatine Dry Process. We are indebted to Dr. Hill Norris for this process. The glasses are to be cleaned with scrupulous care, and coated with the collodion in the usual way, allowing the collodion to set firmly before dipping it into the nitrate bath. The sensitizing having been completed, wash the plate with plain water carefully; drain for a few seconds and immerse in a solution of

Gelatine	128 grains.
Distilled Water	14 ounces.
Alcohol	2½ "

Put the gelatine in cold water and allow it a quarter of an hour to soften and swell, and it will then readily dissolve by applying a gentle heat. Next clarify the solution by adding to it, *whilst barely warm*, a teaspoonful of white of egg (previously beaten up with a silver fork), afterward heating nearly to the boiling-point. The alcohol must now be added to facilitate the coagulation of the albumen. When this takes place and the liquid becomes clear, filter through a clean piece of cambric, folded three or four times. The vessel containing this solution must stand in warm water in order to prevent gelatinization. The plates must be moved up and down two or three minutes. They are then removed, drained in blotting-paper, and dried as described under *Dry Plates*. When dry, they can be stored away in a light-tight box for use. The sensibility remains good for many days. Allow from four to eight times the exposure of the most sensitive moist collodion. To develop the image, make a saturated solution of gallic acid in water; then dissolve 40 grains of pure nitrate of silver in 1 ounce of distilled water. Pour into a flat porcelain dish a sufficient quantity of the gallic acid solution to flood the plate readily. Then to each fluidounce add 10 minims of the solution of silver, or 5 minims in hot weather. It is important that no discoloration should occur on mixing these liquids together, to obviate which, clean the porcelain dish very carefully with nitric acid or cyanide before use, employ a pure solution of nitrate of silver, and mix it with the gallic acid in preference to adding the gallic acid to the silver solution. The picture may be expected to appear in five or ten minutes, and in one hour, or from that to four hours, the development will be complete. If, in spite of all precautions, the developer begins to blacken before the intensity has reached the proper point, it must be poured off and a fresh mixture prepared. Lastly, wash the plate with water and fix it in a solution of hyposulphite of soda.

Gelatine Paper. Paper sized with gelatine. Make a solution of gelatine in warm water, about 5 grains of gelatine to the ounce of water, and while warm immerse the paper, sheet by sheet. To do this readily, take the sheet by two of the corners, curve the end slightly, and pass it *through* the solution, pushing from you. Drain to the last drop, and hang up to dry on pins so placed as to just catch the corners by which the sheet is held.

Gelatine Plates. Glass plates coated with gelatino-bromide of silver emulsion, called dry plates.

Gelatino-Bromide Process. In 1871 Dr. R. L. Maddox proposed a method of preparing photographic plates, in which gelatine took the place of the collodion previously used. During the seventies, this method was improved by many workers, and since 1880, gelatine dry plates have been universally used, manufactured by the gelatino-bromide process. The following is a brief outline of this process: (1) 40 grains of gelatine are soaked in 8 ounces of distilled

water; add 180 grains ammonium bromide and 10 grains potassium iodide. Heat gently, till all is dissolved. (2) In 1 ounce of distilled water dissolve 100 grains of silver nitrate; to this add strong ammonia, drop by drop, till the precipitate at first formed disappears. (3) In the dark-room, warm the solution A to 170° F., and add to it by degrees 165 grains of silver nitrate. When this has dissolved, add solution B. Shake well, and stew for two hours at a temperature of 170° F. (4) Cool the emulsion down to 80° F., and add 300 grains of hard gelatine. Heat the whole to 100° F., and mix well. Now place the vessel containing the emulsion in cold water, when it will quickly set to a stiff jelly. (5) *Wash* the emulsion well by squeezing it through coarse canvas into several changes of water. (6) Add 1 ounce of alcohol to the emulsion; dissolve it by gentle heat; make the total quantity up to 10 ounces by adding distilled water. Lastly, filter the emulsion by squeezing it through swan's-down calico, and it is ready for coating the plates. Such an emulsion will possess extremely high sensitiveness to light.—*Harrison.* (See also *Dry Plates.*) It is almost unnecessary to add that, in practice, the worker will find the commercial makes of gelatino-bromide plates to meet his every desire, rendering the trouble involved in the process given above unnecessary.

Gelatino-Chloride of Silver. A gelatino-chloride of silver emulsion; a solution of gelatine holding finely divided chloride of silver in suspension. Used in making positives on glass (window transparencies, lantern slides), also in the preparation of chloride of silver gelatine paper.

Gelatino-Chloride Paper. Just as gelatine supplanted collodion in the preparation of the sensitive surface in negative-making, so gelatine threatens to take the place of albumen and collodion in the manufacture of printing papers. Photographic paper coated with an emulsion of silver chloride suspended in gelatine is called gelatino-chloride paper. Formulæ for its preparation will be found under *Emulsions*, but the commercial article will be found more uniform and economical than that prepared in an experimental way. Gelatino-chloride emulsions may be flowed upon paper, or opal, or plain glass; prints are obtained in the usual manner under a negative; the manipulation does not greatly differ from that employed with albumen or other well-known papers, and the prints are mounted and burnished in the usual way. Gelatino-chloride paper, very faintly printed, may be developed in a solution of

Gallic Acid	5 parts.
Acetate of Soda	5 "
Tannic Acid	3 "
Water	350 "

Or the following may be used:

Pyro	3 parts.
Citric Acid	5 "
Distilled Water	350 "

Of this solution 20 parts are diluted with 200 parts of water, into which the prints are put without washing. After using either formula, toning and fixing in a combined bath is recommended. By this method of development many more prints can be obtained in a given time than by the older way of printing completely out. This process is also peculiarly adapted for amateurs, who by it are enabled to impress a number of prints in a few minutes during the day, and develop, finish, etc., at their leisure during the evenings.

Gelatinous Paper. This is better known in photography by the French term *papier glacé*, and consists of a peculiar preparation of gelatine in sheets. It is perfectly translucent, smooth, of an absolute continuity, without any texture, and can take different tints without losing its transparency. It is used to preserve, by its interposition, the negatives against the sensitized paper in printing positives.

Gelatinography. A rapid process for obtaining newspaper blocks.

Gelatinotype. Syn., Leimtype. A photo-mechanical process of printing, devised by Husnik, of Prague, in which a film of gelatine is exposed under a negative translated into grain or line, and afterward mounted on a rigid support by the exposed side. Those portions not affected by light are then removed by solvents, such as hot water or a saline solution; the result being a film in semi-relief, suitable for printing in place of the usual wood or metal typographic relief block.

Gilding Solution. A solution of chloride of gold for giving a permanent finish to the daguerrotype.

Glacial Acetic Acid. Concentrated acetic

acid, containing only a single atom of water, and so termed from its property of solidifying at a moderate temperature. At about 50° the crystals melt and form a limpid liquid of pungent odor and a density nearly corresponding to that of water; the specific gravity of acetic acid, however, is no test of its real strength, which can only be estimated by analysis. Glacial acetic acid is sometimes impure, containing sulphurous and hydrochloric acids, which are injurious in photographic processes. Test for these by adding a drop or two of weak nitrate of silver solution to a drachm of the acid, and if they are present, a white deposit of chloride or sulphite of silver will be produced; if *aldehyde* be present, the acid becomes discolored by exposure to light. If glacial acetic acid has a *garlic* smell, it is unfit for use. Glacial acetic acid is useful in preventing fogging (see *Fogging*); in rendering the development slow and even; in the paper-printing process by development; and quite essential in the calotype, wax-paper, and albumen processes. It does not coagulate albumen. (See *Acetic Acid.*) It is a very good solvent of gelatine.

Glass. A combination of various bases, especially alkalies with infusorial earth, the latter predominating. The more the alkalies predominate the more fusible the glass becomes, till finally it becomes a solution (water-glass). Optical glass consists mainly of flint and of crown glass, alkali lime glass (thin, colorless, or greenish glass, flattened by the stretching or cooling process); plate glass, an alkali lime glass, rolled and levelled; colored glass, a glass mixed with various coloring matters, and glass covered with a thin layer of differently colored glass. The sorts of glass used in photography are known as crown, flint, and polished sheet, of which kinds there are innumerable varieties. Crown glass is composed of a mixture of silicates of potash, lime, and alumina. Flint glass is a mixture of silicates of potash, alum, and lead. These sorts are used largely in the manufacture of lenses. For dry plates polished sheet is used, the best kinds being imported from England and Belgium. The finest glass for lenses is the variety known as Jena glass, introduced a few years ago. Opal glass is made by fusing with the metal one of the oxides of tin or zinc.

Glass-Cleaning. This is a very important part of all photographic processes on glass, and should be performed with all the care and thoroughness possible. (See *Cleaning the Glass.*)

Glass Dishes. Oblong, shallow dishes for photographic solutions. They should always be one or two inches larger and wider than the sheets of paper or glass plates to be put into them.

Glasshouse. Skylight-room; a room for making photographic exposures. It is supplied with top and side light, usually facing north, with a system of curtains, reflectors, and other accessories.

Glass Negatives. Negatives produced upon films spread upon sheets of glass. (See *Albumen; Collodion; Gelatine*, or *Negatives.*)

Glass Plates. Sheets of glass used as a vehicle to support films of albumen, collodion, and other substances, for the production of photographic pictures. The purest white glass, perfectly flat and free from defects, should always be used to insure good results.

Glass Positives. Positive photographic impressions produced upon films of albumen, collodion, and other substances, supported by sheets of glass. (See *Ambrotype; Collodion; Positive Proofs*, etc.)

Glass Tubes. Hollow cylinders of glass, from three to twelve inches long and half an inch in diameter. They are used in photography to form the handles of what is called a "Buckle's brush." (See *Buckle's Brush.*)

Glass Vice. An instrument to hold the glass plate while being cleaned.

Globe Lens. Invention of Mr. C. C. Harrison. Once a very popular instrument for outdoor work and copying, but now in disuse, owing to more perfect optical constructions. Many of the new lenses are constructed upon the globe principle, more or less. The outer lens-surfaces of the globe lens would, if continued, form a globe. It consists of two equal menisci, comprises a view field or angle of 90°, and cuts very sharp when well stopped down, but is not very rapid.

FIG. 107.

Glucose. Generally known as grape sugar. It can be made thus: 1 pound of starch, 2½ drachms strongest sulphuric acid, and 1 gallon of water; boil the mixture over a sand-

bath for twelve hours, the loss by evaporation to be supplied with boiling water. After being thus boiled the acid liquor is to be carefully neutralized with chalk, filtered, and then evaporated to the density of about 25° Beaumé, when it will be in a fit state to make the new developing agent of Mr. Lyter. (See *Grape Sugar.*) Glucose reduces the oxides of fine metals to the metallic state without the aid of light. It is hygroscopic and so serves as a preservative in collodion dry plates, and in the dusting-in process.

Gluten. A peculiar substance found in wheat. To prepare: Mix flour with a little water into a stiff paste, and knead this paste in water until the starch and saccharine matter are washed out. It is gray, extensible while fresh and moist, like elastic gum; turns blue when mixed with guaiacum. Sometimes used in photography to re-size paper.

Glutinous Collodion. A collodion which is thick and glutinous, flowing over the glass in a slimy manner, and soon setting into numerous small waves and cellular spaces. The film lies loose upon the glass, is apt to contract on drying, and may be pushed off by the finger in the form of a connected skin. This collodion is produced from pyroxylin made with cold acids; the temperature should be from 130° to 155° Fahrenheit.

Glycerine. A sweet substance formed in the process of saponifying oils and fats. Digest equal parts of ground litharge and olive oil with a little water at the boiling temperature, constantly stirring and replacing the water as it evaporates. When the compound has acquired the consistency of a plaster, wash it well with hot water, decant the latter and filter; then pass sulphuretted hydrogen through it, to throw down the lead; again filter, and evaporate to a syrup in a water-bath. Decolor with animal charcoal. The product much resembles syrup in taste and appearance. It dissolves gallic acid and other substances, but has little or no action upon nitrate of silver in the dark, and reduces it very slowly even when exposed to the light. Glycerine is used as a preservative in the collodion process, also in emulsions and pyro developer, as it retards and gives brilliancy.

Glycin. Hydroxyphenyl glycin. $C_6H_4(OH),NH.CH_2COOH$. It is a developing agent obtained by the action of chloracetic acid on amidophenol. It is a light, lustrous powder, readily soluble in water in presence of caustic or carbonated alkalies; keeps in solution if a sulphite is added, and acts as a powerful developer, although it works slowly compared with pyro or metol. It yields images clear in the shadows, and of a gray-black color, being thereby suitable for dry plates in photo-mechanical work. The addition of potassium bromide has a restraining action, and water added to the developer gives additional softness to the image. The following formulæ are given:

Glycin-Potash Developer:

Glycin	5 parts.
Sodium Sulphite (cryst.)	15 "
Water	90 "
Potassium Carbonate	25 "

For use, dilute with 3 to 4 parts water.

Glycin-Soda Developer:

Glycin	3 parts.
Sodium Sulphite	15 "
Sodium Carbonate (cryst.)	22 "
Water	200 "

If desired, glycin may be mixed for use with either the hydroquinone or eikonogen developers. Negatives developed with the glycin-soda developer are distinguished by freedom from fog, and are very clear and delicate. With a developer composed of

Glycin	1½ grains.
Potassium Carbonate	12 "
Water	1 ounce.

beautifully soft negatives may be obtained by allowing plenty of time in development.

Glycins. Are formed when an atom of oxygen in the amido group of an amidophenol is replaced by the acetic-acid residue, CH_2COOH. They have the general formula $C_nH_{2n-7}OH,NRCH_2COOH$. The glycins of paramidophenol, and other similar substances, can be used with alkali sulphites and carbonates as developers of photographic images. A formula is:

Glycin	3 parts.
Sodium Sulphite	9 "
Potassium Carbonate	5 "
Water	200 "

For portrait work this concentrated solution can be adopted as desired.

Glycyrrhizin. Is obtained from the fresh roots of liquorice, and is a substance intermediate in properties between sugar and resin. It is sparingly soluble in water, but very soluble in alcohol. It precipitates a

strong solution of nitrate of silver white, but the deposit becomes reddened by exposure to light. Glycyrrhizin is used both in collodion and the nitrate bath to produce intensity in the image, but as it tends to decrease sensitiveness in the film, it should be used cautiously.

Gold. This metal, which is more ductile and more malleable than all other metals, has also the peculiarity of having a yellow color. Gold is found native in a state of purity, or in combination with other metals. It has the specific gravity of 19.3, fuses at 32° Wedgwood's pyrometer, and has the atomic number 200. It does not oxidize by being kept in a state of fusion, nor is it tarnished by exposure to the air or moisture. Pure acids do not act upon gold; its solvents are chlorine, nitro-muriatic acid, and nitro-hydrobromic acid. Some of the salts of gold play important parts in photography.

Gold Bath. A solution of chloride of gold in water (mostly 1 : 1000) with different salts added. It is used for improving the color of prints. When organic acids or indifferent organic substances are added to the bath, the tones on albumen paper will be brown; purplish-red when weak, inorganic alkali salts are used; blue-black with strong alkali salts. The nature of the silvered paper is of great influence upon the tone.

Gold-Fabric. Canary-medium. Yellow, taffeta-like stuff, for covering dark-room windows.

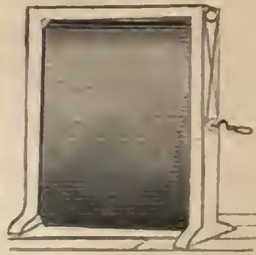
Gold Hyposulphite. Syn., Sel d'Or. An unstable salt of perchloride of gold and hypo soda, used in daguerrotype days, and lately recommended for toning chloride-emulsion prints.

Gold Printing Process. A process by which rich prints of great beauty were obtained on plain paper; devised in 1852. The paper is salted with ammonium and gold chloride, afterward sensitized on a 60-grain bath of ammonio-nitrate of silver; when dry the paper is printed as usual, and fixed in a bath of hypo soda, silver iodide, and water with a small proportion of ammonio-nitrate of silver. The process is now seldom used.

Gold Salts. Substances produced by the action of nitro-muriatic, hydrobromic acid, and chlorine on metallic gold. (See *Chloride of Gold; Auro-Chloride of Sodium*, etc.)

Gradated Background. A few words and the accompanying figure explain this background in a sufficiently clear manner. Take a strip of muslin of suitable width six metres long, and colored progressively, and with continuous gradation, in such manner that at the opposite ends there shall be one metre of white and one metre of black. These two ends are joined together, and thus form an endless band. This is placed on a wooden roller supported by a framework, and put in motion by two wheels; at the bottom another free roller keeps the cloth stretched. The motion may be communicated by hand by means of a crank, or by clockwork. If the operator wants a dark ground, he brings the black part to the front and keeps it there; should he wish it rather lighter, he begins at the white and passes gradually to the darker tints. Another advantage of this apparatus is to keep the background of the pictures free from spots or stains, as the cloth, being in motion during the pose, can leave no trace of them.

FIG. 108.



Gradation of Tone. The gradual blending of one tint into another. The gradual softening-off of the deep shades into the high lights of the picture.

Graduated Background. This ingenious contrivance can be applied to any background with very little additional expense. The additional apparatus required consists of a wooden or opaque cloth frame or hood, projecting all around the upper part of the screen to the extent of about four feet, so as to form a recess of that depth, at the back of which will be the background. This frame can be made to slide up and down by means of a cord and pulley, or it may be hinged on its three sides to the back frame, so that they may open outward. In either case, by a little arrangement the proper amount of light and shade can be obtained on a white background to suit any style of sitter, and thus gray heads, white caps, or light-haired children can be taken with the same background as dark figures. The outside of the hood may be painted light blue or other light tint to suit the remainder of

the room; but the inner part must be of some dark color, so as to avoid the reflection of light on those parts which it is the object of this contrivance to keep in shadow. This decidedly improves the appearance of the picture.

Graduate. A graduated measure; a glass or funnel-like vessel of glass or porcelain with measure-marks for measuring liquids.

Grain. English weight = 0.0648 gramme; 16 grains = 1 gramme, approximately.

Grain. The breaking up of the half-tones of a photographic picture into more or less close dots. In photogravure the grain is produced by dusting resin powder on the warm copper-plate, melting it just enough to make it adhere; in autotypy by the interposition of a transparent screen before the sensitive plate when copying. In phototypy the open grain, which absorbs the water, is formed by drying by heat.

Grain in Photo-Mechanical Work. To produce prints in half-tone by the photo-mechanical processes it is necessary to break up the tones into dots or lines or stipple to permit of their reproduction. This grain is obtained by reticulation of the film, by laying a ground on the plate, of fine powder in a dusting-box, or by photographing the subject with a ruled screen placed before the sensitive plate in the camera.

Grape Sugar. This modification of sugar exists abundantly in the juice of grapes and in many other varieties of fruit. It forms the saccharine concretion found in honey, raisins, dried figs, etc. It may be produced artificially by the action of fermenting principles and of dilute mineral acids upon starch (see *Glucose*). Grape sugar crystallizes slowly and with difficulty from a concentrated aqueous solution, in small hemispherical nodules, which are hard and feel gritty between the teeth. It is much less sweet to the taste than cane sugar, and not so soluble in water (1 part dissolves in 1½ of cold water). Grape sugar tends to absorb oxygen, and hence it possesses the property of decomposing the salts of the noble metals, and reducing them by degrees to the metallic state, even without the aid of light. Cane sugar does not possess these properties to an equal extent, and hence it is readily distinguished from the other variety. The product of the action of grape sugar upon nitrate of silver appears to be a very low form of oxide of silver combined with organic matter. Grape sugar is employed in photography to give increased density to the image, either by adding it to the nitrate bath or to the collodion in the same manner as for glycyrrhizin. It is also used as a preservative for dry plates.

Graphol. Eikonogen developer, brought out by P. Mercier, of Paris. It is in powder form and ready for use when dissolved in water.

Gray Vignettes. Vignettes in which the white ground around the picture has been flushed in the light to a gray shade.

Greasy. An expression applied to sensitized albumen paper when, after silvering, it feels soapy or greasy. This is caused by the paper being too dry, or by not silvering it long enough.

Grinding of Lenses. The engraving represents an optician busied with forming a

FIG. 109.

photographic lens. The operation is to place the optical glass upon a bed in a tank and work over its surface with curved tools, using rouge and other material with water for the grinding element.

Green Fog. A fault in a negative, its shadows appearing light green by reflected light. Happens only in alkali development (especially with caustic potash), or with iron developer when impure chemicals are used. Cause: faulty preparation of the plates.

Green Prints. For some subjects prints with a green tone are desirable. Such prints may be obtained by the use of green carbon tissue or by the following method: Float suitable paper on a 60-grain bath of uranium nitrate, allow to dry, and expose under a negative as usual. After exposure wash over with a weak solution of potassium ferricyanide, by which a red print is obtained. While still wet place this print in a 10-grain solution of sesquichloride of iron, and the color of the print will be changed to green.

Griswold's Albumenized Collodion. This collodion, invented by V. M. Griswold, is made as follows: To 1 quart of collodion prepared in the usual way add 3 ounces of a solution prepared thus: The clear solution which results from white of eggs which have been well beaten, and an equal bulk of pure soft water. When this is added to the collodion it is thrown to the bottom in long stringy white masses, which, after a few days, impart to the liquid albuminous properties, rendering the film closer in texture and bringing out the minor details more sharply and perfectly than by the ordinary collodion.

Griswold's Bromo-Iodized Bitumen. Dilute asphaltum varnish—which has been prepared by boiling together one-half gallon linseed oil, 1 pint Japan varnish, and 5 or 6 ounces asphaltum to such a consistency that it will, when cool, roll into a hard ball—to a proper consistency with spirits of turpentine. Add to 8 ounces turpentine, one-half ounce bromine and 1 ounce iodine, a small quantity at a time, as they unite with great heat and must be managed with care. When thoroughly united this bromo-iodized turpentine, added to a one-half gallon bath of the prepared bitumen, forms the bromo-iodized bitumen. Or take finely pulverized bromide of potassium, 150 grains, to which add 150 grains crystallized nitrate of silver, dissolved in 4 ounces distilled water. Wash the precipitate through nine or ten changes of water. Filter dry in a dark place. Put the dry powder (bromide of silver) into a long 8-ounce vial containing 4 to 6 ounces turpentine and add to it 1½ ounces iodide of potassium very finely pulverized. This will form the bromo-iodide of potassium and silver in turpentine, which add to the one-half gallon of bitumen prepared as above. Bitumen so sensitized will give impressions without the aid of collodion. It renders a collodion film more sensitive and may be used for taking pictures on paper or any other hard, smooth substance.

Ground-Glass. Glass to which a matt surface is given by grinding with emery or similar substances; has many uses in photography. It forms the screen in all cameras upon which the image produced by the lens may be seen and focussed. It is used to glaze the studio lights in order to secure softer definition and diffusion of the light. Ground-glass plates coated with sensitive emulsion are advised instead of the plates usually used, for the avoidance of halation in photographing interiors. Plain ground-glass plates are also used to soften hard negatives in various printing processes, and to obtain prints with a matt surface, for which purpose the print is squeezed to the ground-glass and left to curl off when thoroughly dry.

When ground-glass is unobtainable for focussing and other purposes, plain glass coated with the following will serve:

Sandarac	18 grains.
Mastic	4 "
Ether	200 minims.
Benzole	80 to 100 "

The more benzole used the finer will be the matt surface obtained.

Group. The collection of two or more figures upon one plate or in one picture. An assemblage of objects whose lighted parts form a mass of light, and their shaded parts a mass of shadow. It is impossible to give any definite directions for forming groups: so much depends upon the individual nature and conformation of the models, and upon the nature of the accessories called into requisition. Artistically the effects of grouping are very little studied by photographers, yet much of the beauty of a picture of several figures depends upon the manner in which this is done. Not only the place for each figure should be properly chosen, but the space to be occupied, the surroundings, and the general conformation of each subject should be studied, and the arrangement made so as to bring forward all the most pleasing and prominent points, and keep the least promising in the background. The works upon art should be studied. For this kind of work quick plates and lenses are indispensable, and as good a light as is obtainable. As a branch of professional work

group-photography is pleasant and profitable and deserves more attention than it receives. For outdoor groups the same conditions apply.

Guaiacol. Syn., Methyl catechol. A colorless, oily liquid with a pungent odor, obtained by dry distillation of guaiac resin. Prepared by Waterhouse as a developing agent. Guaiacol is sparingly soluble in water, and dissolves readily in alcohol. When it is mixed with caustic soda it acts as a developer, giving harmonious negatives of a brown color. It has been suggested that the reducing action of guaiacol is due to some impurity, as when carefully purified it does not possess any reducing action.

Guaiacum. This is one of the *gum resins.* One of the most remarkable properties of guaiacum is its turning blue in contact with gluten and several other substances in the air; nitric acid and aqueous chlorine turn it successively green, blue, and brown. An alcoholic tincture of guaiacum, rendered milky with water, recovers its transparency on the addition of caustic potash in excess; but this is not the case when resin is present. A delicate photographic paper may be formed by first washing with an alcoholic solution of guaiacum resin, and afterward with one of neutral acetate of lead. It is soluble in alcohol, is light-sensitive, and possesses developing qualities.

Gulliver's Paste. Photographers often find it inconvenient to prepare starch paste in small quantities; but the following mixture, invented by Mr. Thomas Gulliver, when once made will keep for months ready for use, and will be found excellent for mounting pictures. It is smooth as oil, easy to prepare, does not thicken, and will stick like glue; it also has the advantage of not cockling the prints so much as the ordinary starch paste. Take of

Picked White Gum-Arabic	1/4 ounce.
Dextrin	2 3/4 ounces.
Liquid Ammonia	4 drops.
Water	8 ounces.

The gum-arabic is to be pounded in a mortar, and mixed with the dextrin; then rubbed in the mortar, with 2 ounces of the water, till quite smooth; then the rest of the water added, and boiled in an enamelled saucepan for ten minutes. When cold it may be put into a wide-mouthed bottle, the ammonia added, and thus kept for use.

Gulliver's Varnish. A solution of gum benzoin in alcohol, introduced by Mr. Thomas Gulliver, made in the following manner:

No. 1.	Gum Benzoin	30 grains.
	Alcohol	1 ounce.
No. 2.	Gum Benzoin	45 grains.
	Alcohol	1 ounce.

Powder the gum in a glass or Wedgewood mortar, gradually adding the spirit; then filter through blotting-paper; the next day it will be fit for use; or it may be poured into a tall bottle and left to subside gradually. The above are for negatives: No. 1 for those intended for working off a few prints only; No. 2 for those negatives from which some 1000 or more may be required. For positives, add a little animal charcoal, and it will soon become clear as water; after filtering it, varnish a positive with it, and when quite set apply the black varnish on the benzoin varnish; the picture will remain pure and much improved.

Gum. Different plant stuffs, forming (dissolved in water) slimy, sticky liquids. The most important are: gum-arabic (insoluble in alcohol, ether, and oils), used for mounting; gum dammar (soluble in benzene), used as varnish; gum tragacanth, forming, when boiled in water, a thick solution resembling that of gum-arabic and used for mounting chromo-photographs.

Gum Anime. An exudation of the *Courbaril* tree of Cayenne and the equatorial districts of South America. It is exported in lumps of different sizes, often including perfect insects and parts of other organic remains of living species; hence it has derived its name, as being animated. It contains a little volatile oil, is resinous, of a light-brown color, brittle, and transparent. Alcohol and essential oil of caoutchouc mixed, dissolve anime into a jelly, but not perfectly.

Gum-Arabic. A vegetable product produced from the *Acacia vera*, distinguished, like most other gums, by its solubility in water, and insolubility in alcohol. It is tasteless and inodorous. Its solution is viscid, and is termed mucilage. Gum-arabic is used in photography for manufacturing sealing paper, in mounting photographs, and for making a preservative for dry collodion.

Gum Dammar. Dammar. White resin from the East Indies, soluble in benzene and

spirits of turpentine. Used in the manufacture of varnishes.

Gum-Gallic Process. A dry collodion process introduced by R. M. Gordon, in which gallic acid and gum-arabic were a special feature. Plates prepared by this process kept well, and were about as rapid as wet collodion plates.

Gum-Lac. Lac. Hard resin, imported from the East Indies, consisting mainly of shellac and red coloring matter. Used for various varnishes. Mixed with iodide of ammonium it was used as a substratum in the albumen process; more recently as an addition to gelatino-bromide of silver emulsions.

Gum Paper. (See *Sealing Paper.*)

Gum Resins. Inspissated vegetable juices, consisting of extractive and resinous matter. They are partly soluble in alcohol and water.

Gum Sandarac. This substance, sometimes called gum juniper, is a peculiar resin, the product of the *Thuya articulata*, a small tree which grows in the northern part of Africa. The resin of commerce is of a pale-yellow, transparent color, brittle, and of a spherical or cylindrical shape. It has a faint aromatic smell; does not soften, but breaks between the teeth; fuses readily with heat, and has a sp. gr. of from 1.05 to 1.09. It contains three different resins: one soluble in spirits of wine, one not soluble in that menstruum, and a third, soluble only in alcohol of 90 per cent. It is used in photography for varnishes.

Gun-Cotton. Explosive cotton, pyroxylin, trinitro-cellulose. A body obtained when cellulose (cotton, linen, paper) is treated with concentrated sulphuric acid, then washed and dried. Looks like cotton, but feels rougher; sometimes comes in amorphous powder form of yellowish-white color, according to its manner of preparation. Is insoluble in water, soluble in acetic ether, acetic acid, amyl-acetate, methylated alcohol, and in a mixture of ether and alcohol; ignites at 120° and burns without leaving a residue. Used for collodion and emulsions, in the preparation of celluloid, Bengal paper (for igniting magnesium powder), etc.

Gurney's Compound. A dry accelerator for the daguerrotype plate, invented by Mr. J. Gurney; it is composed of *chloride* of lime, bromine, and starch, in the same manner as the bromide of lime accelerator.

Gutta-Percha. The concrete juice of a large forest tree (Sapotaceæ), of Borneo, Malacca, and the neighboring countries. Gutta-percha is of a dirty pinkish-white color, solid, having little smell, and is insoluble in water; it has a silky, fibrous texture, especially when drawn out. It feels smooth and greasy between the fingers. Below 50° it is hard, tough, and partially flexible, when thin like horn; between 50° and 70° it is elastic and more flexible, yet still tough and stiff; between 140° and 160° it becomes quite soft and plastic, and loses its tenacity. In this state pieces of it may be joined, all that is necessary being to press them together. By cutting it up into fragments and boiling in hot water, most of the impurities may be removed. When thus purified, by cooling it passes into a solid mass; when softened by either hot water or by dry heat, it may be moulded into any shape. When hot it is easily cut with the knife or saw, but when cold it is difficult to cut it without wetting the tool with cold water. It is lighter than water and floats on it, the specific gravity being when pure 0.9791. In its chemical relations it closely resembles caoutchouc, and is isomeric with it; it differs, however, in some physical properties. By destructive distillation it yields similar products, affording a clear, limpid oil of a mixed composition between 360° and 390°. It is insoluble in alcohol and water, dissolves partially in oil of turpentine and ether, and perfectly in cold naphtha, benzole, sulphuret of carbon, and caoutchicine. Of these benzole is the fittest; when dissolved in it by the aid of gentle heat, and then poured upon a plate of glass, the benzole evaporates and leaves the gutta-percha behind in the form of a white film or skin. Gutta-percha is one of the most powerful negative electrics, and may be used for insulating positive surfaces, or for developing quantities in place of the glass cylinder. Gutta-percha is used in photography in the manufacture of baths, dishes, funnels, and bottles; as a sizing for paper, as a vehicle on which to transfer the collodion film, and sometimes in combination with collodion.

Gutta-Percha Collodion. By the addition of gutta-percha to collodion the collodion is not only rendered tougher but more sensitive.

Gutta-Percha Paper. Dissolve gutta-percha in benzole; let the precipitate settle and decant off the clear liquid. Put this into a porcelain dish, *immerse* the sheets of

paper, one at a time, and hang up to dry. When dry they are rather more transparent than before immersion, but exhibit the original glaze, only within the pores may be observed an infinity of little white grains of gutta-percha, which melt when held up before the fire and combine so as to form an internal varnish or species of sizing, which renders the paper impervious to liquids, and comparable to a sheet of glass. It may then be albumenized and printed upon in the ordinary way; the final washing, however, does not require so much trouble as that usually bestowed. Gutta-percha paper is also used for printing upon the collodion film. Take a plate of glass, pass over it with a brush a coat of glycerine, and make the sheet of paper adhere to it, avoiding air-bubbles; then spread over it a film of iodized collodion in the usual way; lift up the paper and plunge it in a bath of nitrate of silver of 6 per cent. Take care to leave the collodion side upward. When the iodide of silver is formed, lift up the paper, let it drain a minute, and wash it in two waters; then replace it on the glass, which retains some of the glycerine, or if not, some may be added. The paper is now ready for use. If the required exposure to light be long, it will be as well to pour over the collodionized surface a mixture of glycerine and nitrate of silver in the following proportions:

Distilled Water	6 ounces.
Nitrate of Silver	16 grains.
Glycerine	232 "

Develop the image as on glass and fix in the usual way. After fixing, lift the paper from the glass and wash out carefully all the glycerine.

Gutta-Percha Transfers. Collodion pictures transferred to gutta-percha. The process is thus given: First make a solution of

Pure Gutta-percha	31 grains.
Chloroform or Benzole	1 ounce.

There are cases where the formula should be varied, but in each case the operator will have to decide for himself. When the negative on the glass is dry and in good condition, pour on the collodion side a coating of the above solution. Let it run slowly and uniformly, that it may have time to penetrate and unite with the collodion film. As soon as this coating is completely dry, strengthen it with a second, formed of the following substances:

Gelatine	465 grains
Isinglass	77 "
Alcohol	½ ounce.

Put the gelatine in as much water as will absorb it, until it has swelled to the utmost; melt it by placing the bottle containing it in hot water. Melt the isinglass in the alcohol in the same way. Mix the two solutions together by degrees and with care, stirring with a wooden spatula. Warm it with precaution, that it may not be injured by too much heat. Hold the negative, the gutta-percha coating upward, before a clear fire, or over a spirit lamp, until it is heated to 10° or 20° Centigrade; then pour over it immediately (removing it from the flame of the lamp) a coating of the gelatine as thin as its density will allow. Leave it for an instant to cool and dry, sheltered from dust, and you will be able to remove easily, by means of steam from boiling water, this triple film of collodion, gutta-percha, and gelatine. This operation is performed as soon as you see that the film is slightly softened by the steam, and you should then begin to remove it from the glass at the corner from which the excess of collodion was poured off when the plate was collodionized. Various ways, which will suggest themselves to the operator, may be used to facilitate the removal. As soon as the entire film is raised, flatten it between two pieces of glass having good surfaces, and sufficiently thick to act by their own weight. The collodion used must have *sufficient* consistency, not so much, however, as to leave striæ or lines on the plate when dry. The gutta-percha solution must stand four or five days to settle and clear before use.—*H. H. Snelling.*

H.

Haakman's Taupenot Process. This is a modification of the Taupenot or collodio-albumen process, very highly spoken of. The process is as follows: (1) Clean, collodionize, and sensitize in the ordinary nitrate of silver bath. (2) Thoroughly wash under a tap. (3) Cover with iodo-brominized albumen. (4) Immediate immersion in a dish filled with boiling, or nearly boiling water, taking care to let the water overflow the

surface in continual waves. Having taken the plate from this bath, keep it again for a few moments under the tap to clean the back, lowering the temperature to the mean of the second silver bath. (5) Give the plate its final sensitizing in the second silver bath. (6) Thoroughly wash under a tap and put aside to dry. When wanted for use let the plate rest by the upper edge for about half an hour against a stone bottle filled with hot water, to insure equal dryness and equal development. Develop with 3 grains of pyrogallic acid and 1½ grains citric acid to the ounce of water, with the addition of very little silver solution of 27°. The collodion may be very fluid and contain a bromide in the proportion of 2 grains iodide to 1 grain bromide. The second sensitizing bath should contain acetate of lead. Washing with dilute gallic acid after the washing following sensitizing, is considered helpful.

Hair Sieve. A sieve with very fine meshes, used in the washing of gelatino-bromide of silver emulsions.

Halation. The term used to denote the spreading of light beyond its proper boundaries in the negative image upon the plate, producing local fog around the high lights. Thus in negatives of interiors, halation is apt to occur around windows facing the sky, as also around tree branches standing out against the sky, in a landscape. Halation is caused by the reflection of light from the back surfaces of the plate. The remedies are various; of these the simplest is the use of one of the commercial makes of non-halation plates; another is to back the plate with a removable coating composed of a thin solution of bitumen in benzene, which can be afterward removed with a rag moistened with benzene; or the following mixture may be used:

Powdered Burnt Sienna	1 ounce.
Gum	1 "
Glycerine	2 drachms.
Water	10 ounces.

Glazed black paper or American cloth can also be utilized, pressed against the back of the plate during exposure.

Half-Tones. The lighter shadows; gradations from light to shade in a photograph. A picture without half-tones is harsh.

Half-Tone Negative. A negative from a washed drawing, painting, or natural object, consisting not only of black and white, but of all the gradations.

Half-Tone Process. A name given to photo-etching upon zinc or copper; photo-engraving in half-tone.

Hallotype. A positive photograph colored in a style invented by J. B. Hall. The process consists in printing two paper positives from the same negative, superimposing one upon the other between two plates of glass, and backing them with a piece of white cardboard. The front positive is rendered transparent by gum dammar dissolved in turpentine, or by olive oil; the back positive is colored roughly and laid down upon the back of the first and pressed into close contact. Care must be taken that the outlines of the two pictures match perfectly.

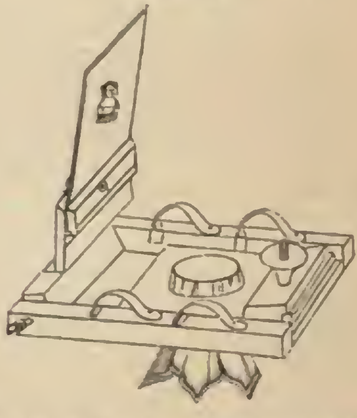
Haloids. Of the substances most easily affected by light, the three of chief interest to the photographer are the chloride, iodide, and bromide of silver. These three salts are called the silver haloids or the haloid salts of silver.

The haloids are salt-like combinations of metals with bromine, chlorine, iodine, and fluor. The haloid acids are hydrogen combinations with the above.

Hand-Cameras. Small cameras including every requisite for the exposure and changing of a number of plates; made in very compact form so as to be portable, have the generic name of hand-cameras.

Handkerchief Printing Frame. For printing on handkerchiefs or other fabrics.

Fig. 110.

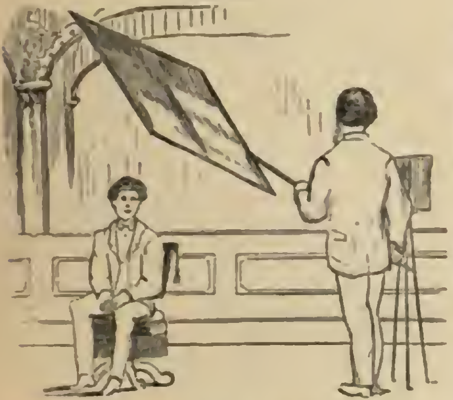


Take any ordinary porcelain printing-frame and through the bottom bore a hole, say 2½

inches in diameter. Fit this with a nice smooth tapering cork, so that the farther it is pushed up through the hole the tighter the fit. Now, over the face and small end of the cork lay the fabric, push it up though the hole in the printing-frame, and thus you secure a surface as hard, even, and as easily printed upon as a piece of ground porcelain. The cut will make the whole matter plain.

Hand-Screen. The device of Mr. J. H. Kent. By its use, effects are obtainable which could not be had in any other way.

FIG. 111.



Using it, shadows may be thrown upon any part of the face, during the whole or a portion of the exposure. The edges of the shadows may be so softened into the lines and middle tints as to render the whole effect harmonious. This gives the operator a valuable power when he uses judgment.

Hannaford's Fothergill Process. This modification of the Fothergill process consists merely in the application of the albumen solution. To the white of one egg add three ounces of water and about twelve minims of ammonia. This, well beaten, is the ordinary mixture of the Fothergill plates. Now add silver solution, drop by drop; at first a white precipitate is formed, but quickly re-dissolves. Directly, however, this albuminate of silver is no longer so re-dissolved, cease. The mixture should present a slightly milky appearance, and in this state may be kept for some time. Its keeping qualities, however, will be better with the addition of just ammonia enough to dissolve the milky precipitate. After sensitizing the collodion film thoroughly and washing in plenty of water, pour on the albumen mixture and allow it to flow over the plate for about a minute. Then again thoroughly wash and dry. It is not needful that the albumen should be removed by washing. The mixture should be quite clear, ammonia being *slightly* in excess.

Hard (Hardness). Terms applied to those photographs in which the outlines and details are all abrupt, without sufficient gradation of light and shade; in which the high lights are chalky and the shadows perfectly opaque and matted, and the figure or figures appear plastered upon the background, without separation or relief, and the whole picture without atmosphere. This state of a picture is often mistaken for sharpness.

Hardening the Film. To toughen the soft, sticky negative or paper films by a treatment with alum, tannin, etc., preventing abrasion and frilling.

Hardwich's Collodion. This is made by introducing one-half gallon of alcohol, sp. gr. 0.850, into a 2-gallon stoppered bottle and adding 1900 grains dry pyroxylin. When the pyroxylin has become thoroughly saturated with alcohol pour in one-half gallon ether, sp. gr. 0.725, and agitate for two or three minutes; next add one-half gallon more of ether and shake for a few minutes. After this the collodion may be allowed to settle for about a week or ten days before use.

Hardwich's Toning Process. Make a solution of gold, 1 grain to 1 ounce of water; take of this solution of gold 1 fluid-drachm, sesquicarbonate of soda 1 drachm, citric acid 20 grains, pure water 12 fluidounces. Mix the ingredients in an evaporating dish, and when effervescence ceases place a spirit lamp beneath and raise the temperature with constant stirring to about 120° F. The lamp must now be removed, else much of the gold will be reduced. This warm liquid is poured into a dish, and the prints are put into it two or three at a time. A little discoloration of the toning solution may be disregarded.

Harmonious Coloring. The art of laying on colors in painting, so that one color may harmonize with another in analogy and contrast.

Harmony of Colors. The union or connection between the colors with respect to the nature and subjects of the painting, and the relation the colors bear to each other.

Harmonization of Photographic Solutions. Dr. Schnauss, of Germany, introduces this subject to the photographer in a series of experiments going to prove the necessity of perfect harmony existing between photographic solutions. The collodion process, he says, possesses, when compared with the other negative processes upon paper, albumen, etc., an extraordinary subtilty or delicacy of photo-chemical changes. To these alone the high sensitiveness and beautiful results of the collodion process are due; but, on the other side also, are its great difficulties. The centre of gravity of this whole process, especially if rapid fine negatives are to be produced, lies in the exact quantity of the *acidifying principle* in the three most important solutions: 1. The *iodized collodion*. 2. The *nitrate bath*. 3. The *iron developer*. Because this *acidifying principle* can be neutralized by opposed agents possessing *alkaline* properties we also must contemplate this latter class of substances when harmonizing our solutions. In chemistry the acids and alkalies are especially characterized by the fact that the first reddens the blue litmus or the Georginen paper; the latter ones make the red litmus-paper blue, or the Georginen paper green. But in photography there are much finer differences, which cannot be examined by the before-named test-paper. The photographic forces themselves must be used to find them out, *i. e.*, a proof must be made. By this experiment we find among the photographic chemicals, especially in those which serve to iodize the collodion, two classes of a strongly expressed polarity or of photographic oppositions, the knowledge of which contributes very much to a sure operation. In the negative as well as in the positive collodion process, the *acidifying principle* must *predominate* in a more or less high grade, according to circumstances. In the negative process *acetic acid* must be added to the nitrate bath and developer; in the positive process *nitric acid* is added to the bath and acetic (or nitric) acid to the developer. In order to bring a small quantity of the acidifying principle into the collodion none of the strong acids may be used; we must here take the substances which are *only by photography* known as acidfying, viz., the pure iodine, or an iodide containing free iodide. In harmonizing the solutions, especially their *age* is to be brought into consideration. All three solutions being freshly prepared, no good results can be immediately obtained with them. The amount of acetic acid in the bath and developer is then to be augmented in order to obtain clear, vigorous negatives. Find in the following some indications as to the best preparation of the three solutions, always supposing that they must reach a certain age or maturity before they are able to show their whole worth. The *collodion* should be composed of good, freshly prepared pyroxylin and a mixture of 2 parts of ether and 1 of alcohol. It must be good and flow evenly over the plate; it should not form any streaks (or it is too thick), but must possess enough consistency to hold the iodide of silver which is formed in it during the immersion in the nitrate bath. The iodizing solution consists of: Alcohol (sp. gr. 0.835), 1 ounce; iodide of ammonium, 24 grains; iodide of cadmium, 12 grains; bromide of cadmium, 6 grains. This solution should stand some days and obtain a wine-yellow color before it is used. One adds so much of it to the collodion that the film becomes dense enough. For the preparation of a good and homogeneous film of iodide of silver with the *ethereal* collodion the amount of water is also to be taken into consideration.

Harsh. Applied to a photographic picture, this term means that it is of a ragged and abrupt outline, and of a rough, spotted appearance in the lights and shades; cold; not harmonious or soft.

Hartshorn. A name sometimes given to ammonium hydroxide, NH_4-OH, or liquid ammonia.

Fig. 112.

Head-Rest. In former days when the time of exposure in portraiture was necessarily more protracted

than it is now, various contrivances were devised to support the sitter's head and figure during the exposure. Some of these, of light steel or metal, were affixed to the back of the posing-chair, others were fixed to a separate stand. Owing to the increased rapidity of modern plates and the power of the developers now employed, head-rests are little used except for old people and nervous subjects or in dull light.

Head and Body Rest. This helpful apparatus was one of the earliest servants of

FIG 113.

the photographer. It is now constructed of many forms, and some of its kindred are exceedingly elaborate and cumbersome.

Heat. Heat, as a cause of sensation, is considered by some to be the result of the vibration of elastic media; by others as a subtile fluid, contained in a greater or less degree by all bodies. In *chemistry* it is called *caloric*. It expands all bodies in different proportions, and is the cause of fluidity and evaporation. A certain degree of it is also essential to animal and vegetable life. Heat is *latent* when so combined with other matter as not to be perceptible. It is *sensible* when it is evolved and perceptible. Heat has greater or less influence in photographic processes according to its state. It is quite impossible to obtain satisfactory results with a high temperature, 65° to 80° Fahr., being the best to work by. A high degree of temperature also produces a yellow, hazy atmosphere which retards the action of light in the camera and renders the impression very unsatisfactory, producing a confused, misty image.

Heliochart. A name proposed by Mr. M. A. Root for photographic proofs upon paper.

Heliochrome. The name applied by M. Niépce de St. Victor to his process for taking photographs in the natural colors. The following is the substance of Mr. Victor's memoir on this process: "Having formed the idea from what I had observed, that there might exist a relation between the color that a substance communicates to flame, and the color that light produces on a plate of silver which has been chlorodized with the substance which colors that flame, I undertook the series of experiments which I am now about to submit to the Academy. The bath in which I plunged the plate of silver was formed of water saturated with chlorine, to which I added a chloride which possessed the property of giving to flame the color which I desired to reproduce on the plate. It is known that the chloride of strontium imparts a *purple* color to flame in general, and to that of alcohol in particular. If a plate of silver be prepared by passing it into water saturated with chlorine to which chloride of strontium has been added, and the surface of a picture colored in red and other colors be then applied to the plate, and exposed to the light of the sun, after ten or fifteen minutes it will be remarked that the colors of the image are reproduced on the plate, but that the red is much more decided than the other colors. When it is desired to reproduce successively the six other rays of the solar spectrum, the same course is pursued as has just been pointed out for the red ray, by employing for *orange* the chloride of calcium, or that of uranium; for *yellow* the hypochlorate of soda, or the chloride of sodium, or of potassium, as well as pure liquid chlorine; for if a plate of pure silver be plunged into liquid chlorine for some time and then exposed to the flame of an alcohol lamp it produces a beautiful yellow flame. If a plate of silver be plunged into liquid chlorine, or exposed to its vapor (but in this latter case the ground of the plate remains always dark, although the colors are produced), all the colors will be developed by the action of light, but the yellow alone will possess brilliancy. I have obtained a most beautiful yellow by means of a bath composed of water slightly acidulated with hydrochloric acid and holding in solution a

salt of copper. The *green* ray is obtained by means of boracic acid or chloride of nickel, as well as by the salts of copper. The *blue* ray is produced by the double chloride of copper and ammonium. The *indigo* ray with the same substance. The *violet* ray is procured by the help of chloride of strontium and sulphate of copper. In fine, if alcohol slightly acidulated with hydrochloric acid be set on fire, there results a yellow, blue, and greenish flame, and if a plate of silver be prepared with water acidulated with hydrochloric acid, all these colors are produced by the action of light; but the ground of the plate is always black, and this preparation of the plate can only be made by the acid of a galvanic battery. It appears, therefore, that all the substances which produce colored flames yield also colored images under the action of light. If I take now all the substances which give no color to flame, I shall in like manner produce with them images uncolored by light; that is to say, a negative image alone will appear on the plate, with no colors but black and white, as in ordinary photography. Certain substances yield white flames, as the chloride of antimony, the chlorate of lead, and the chloride of zinc. The first two give a bluish-white flame, and the last a white flame feebly tinted with green and blue. These three chlorides yield no colors by light if we use them alone; but if we mix them with other substances which do produce colors, we obtain in addition white grounds; a thing very difficult to obtain, from the fact that, properly speaking, there exists no black or white in the phenomena of coloration; and when I have succeeded in obtaining it, it is only by means of chloride of zinc or chlorate of lead, which I add to my baths, though only in very minute quantities, as they hinder the production of the colors. I have reproduced all the colors of a copy by preparing the plate in a bath composed of deuto-chloride of copper. This result, it appears to me, is explained by observing the fact that a flame of alcohol or of wood, into which chloride of copper has been thrown, exhibits not only the green, but all the other colors of the spectrum in succession, according to the intensity of the flame; the same phenomena occur with almost all the salts of copper mixed with chlorine.

I have already said that liquid chlorine acts upon the plate of silver by a simple immersion and gives all the colors, but they are feeble (with the exception of *yellow*); this arises from the fact that the coating is too slight, and cannot be rendered thicker without the aid of the battery. If a salt of copper be put into the liquid chlorine, a very thick coating will be obtained by a simple immersion; but the mingling of copper and liquid chlorine always acts badly. I prefer to take some deuto-chloride of copper to which I add three-fourths of its weight of water. This bath gives very good results. However, there is a mixture which I like better still. It is to put equal parts of chloride of copper and chloride of iron with three-fourths water. The chloride of iron has, like that of copper, the property of acting upon the silver plate, and producing several colors; but they are infinitely more feeble, and it is always the yellow that is most decided; this is in accordance with the yellow color of flame produced by the chloride of iron. If a bath be formed composed of all the substances which separately give a dominant color, the colors will be obtained all very vivid, but the great difficulty is to mingle them in proper proportions, for it most always happens that some colors find themselves excluded by others, though I doubt not we shall succeed in reproducing all. I have proved that the phenomena of coloration by light manifest themselves equally well in a vacuum as in the presence of atmospheric air; consequently oxygen has no share in the operation; there remain then three agents—water, heat, and light—which are the most important. I have studied the property of each chloride, whether separately or simultaneously with the liquid chlorine or with a salt of copper; for if the silver plate be not prepared by means of the galvanic battery, a salt of copper is indispensable to obtain a coating of sufficient thickness, and in that case the colors are much more brilliant. I proceed to give the nomenclature of all the chlorides that I have employed, placing them in classes.

"*First class.* Chlorides which being employed alone act upon the plate of silver so as to make it take all the several colors of the model. These are the chlorides of *iron*, of *nickel*, of *potassium*, and the hypochlorides of soda and of lime, as well as liquid chlorine, by immersion or in vapor.

"*Second class.* Chlorides which being employed alone act upon the plate of silver, but yet give no colored images under the action of light. These are the chlorides of

arsenic, antimony, bromine, bismuth, iodine, gold, platinum, and sulphur.

"*Third class.* Chlorides which, when used alone, do not act at all upon the plate, but which *do* act upon it when mixed with a salt of copper (especially with the sulphate or nitrate of copper), and which then give colors under the influence of light. These are the chlorides of *aluminium, silver, barium, cadmium, calcium, cobalt, tin, manganese, magnesium, phosphorus, sodium, strontium, and zinc.* Hydrochloric acid diluted with one-tenth water and mixed with nitrate of copper, acts upon the plate and gives all the colors.

"*Fourth class.* Chlorides or chlorates which, although they act upon the plate, when mixed with a salt of copper, do not reproduce the colors. These are the chloride of *mercury* and the chlorate of lead.

"The first class embraces those which act, indeed, upon the plate; but as none of them give color to flame, they in like manner give no colored photographic images, even when mingled with a salt of copper. The third class consists of chlorides, which, of themselves, exert no action on the plate, and which impart no color to flame (except those of silver and zinc, which give feeble colors); but, on mingling them with a salt of copper they form a chloride of copper, and in that event become capable of acting upon the plate and producing the photographic colors. The fourth class embraces those chlorides which, though capable of producing an image on the plate when used with a salt of copper, yield no photographic colors; these in like manner give no color to flame when burnt alone, and when combined with copper impart only a green color. There is still a large number of chlorides with which I have not experimented, because they are too costly to admit of my employing them, particularly in forming baths. These chlorides are those of *carbon, cerium, chromium, cyanogen, iridium, molybdenum, palladium, silicium, rhodium, titanium, tungsten,* and *zirconium.*

"I have formed all my baths of one-fourth by weight of chlorine, and three-fourths of water; these are the proportions which have appeared most suitable. When hydrochloric acid with salt of copper is used, it is necessary to dilute it with one-tenth of water. The liquid chlorine ought not to be concentrated if it is desired to obtain good yellows. In the baths composed of several substances it is necessary to filter or decant the liquid, in order to leave it perfectly clear. It is then put in a close-stoppered bottle to use when needed. It is best to take from this liquid only the quantity necessary to prepare two plates at most, because the bath loses strength considerably at each operation, though it can be restored by putting in a few drops of hydrochloric acid. Having operated on silver containing $\frac{1}{1000}$ part of copper, I have obtained colors much more vivid than on a plate containing $\frac{1}{10}$ of copper. I afterward operated on a plate containing $\frac{1}{16}$ part of copper, and obtained only very dark impressions, so that the *purest* silver will always be preferable for these experiments. The plate being perfectly cleaned (and for this purpose it is necessary to make use of ammonia and tripoli) it is plunged quickly into the bath and left there for some minutes, in order to receive a sufficiently heavy coating. On withdrawing the plate from the bath, it is rinsed plentifully with water, and then dried over a spirit lamp. It takes in the bath a dark color almost black, and if it be exposed in this state to the action of light, the colors will be produced, it is true, but much more slowly, and the ground will be entirely black; it is necessary, in order to have a clear ground and a more rapid operation, that the plate be changed by heat to a cherry-red tint; this is the color at which (as before said) it is best to expose it to the light. The time of exposure varies greatly, according to the preparation of the plate, but it must be calculated that two or three hours will be necessary to obtain a picture in the camera; this is a long time undoubtedly, but the question of acceleration being altogether secondary, I have not yet given it my attention. I will, however, mention the fluoride of soda as an important quickening agent, also chloric acid, and all the chlorates.

"To obtain all the colors at once there must be taken the proportion of chlorine or chloride corresponding to the yellow and green rays, and in this case there will be several colors by allowing the plate to become suitably prepared in the bath; that is to say, the bath ought always to be at a temperature of 10° Centigrade, at the least, and the plate should be immersed in it for about five minutes. The thickness of the coating laid on, as well as the absorption of the bath, causes a difference in the effect; it is therefore very essential to operate always under the same conditions if the same results be desired.

(The mixture of the chloride with the salt of copper should be made cold, or at least at a moderate temperature.) When several colors are obtained on the plate they are much less vivid than when only one predominant color is required. This is the reason that it is so difficult to obtain several colors at once, of great intensity, particularly with white grounds, and to copy the dark parts at the same time. I mentioned that the feeblest quantity of chlorine or chloride furnished yellows; but to have indigo and very bright violet there will be no yellow. The red, alone, is always produced, because this color is caused by the heat of 100° Centigrade, to which the plate has been first of all exposed before any action of the light; however, with yellows the red is very feeble. The finest reds are obtained with a large quantity of chlorine or chloride, except with the acid chlorides, such as those of zinc and tin, and hydrochloric acid, which furnish very good results when they are mixed with a salt of copper in suitable proportions; but if in excess, there will be produced only a violet color. In this case the ground of the picture is very clear, and the lines very pure. With the neutral chlorides, when united to a salt of copper, it happens that if in excess they produce very bright colors, particularly the reds and those of an orange tint, but the ground of the plate is always dark; this is the case particularly with the perchloride of iron. If a mixture is made of one part of chloride of iron with four of a salt of copper in 300 parts of water, all the colors will be obtained with white grounds, but they are not very bright. If a mixture is made of 100 parts of chloride of magnesium with 50 parts of sulphate of copper, all the colors will be copied, and they will be brighter than the preceding, but the ground will always be dark or pinky."

In a subsequent memoir Mr. Victor says:

"Having obtained by contact—that is, by applying the face of a colored engraving to a sensitive plate, and covering it with a glass, and exposing it to the light—all that was possible to attain in that stage of the business, I then sought to attain the same results in the camera. As I had anticipated, I encountered great difficulties, but to a certain point have succeeded in surmounting them. I have now ascertained that the reproduction of all the colors is possible, and that in order to obtain them it only remains to learn how to prepare the plate in a manner most suitable for the process. I commenced the experiments by copying in the camera some colored engravings, then artificial and natural flowers, and then still life (*à nature mort*). I took a doll figure which I dressed with stuffs of different colors, trimmed with gold and silver galoon, and all these colors I have obtained. And what is very curious and extraordinary is that the gold and silver were presented with their true metallic lustre. I have also produced pictures of porcelain, crystal, alabaster, precious stones and glasses, with the lustre which belongs to them; and while pursuing my experiments with these, I observed an exceedingly curious fact, which I think I ought to insert here.

"I had exposed to the camera a deep-green glass which gave a yellow image, instead of green, whilst a high green glass placed by the side of the other was perfectly reproduced with its true color. The great difficulty—and that which had all along, until now, obstructed my progress—was to obtain the various colors all at once; nevertheless, this is possible, since I have succeeded in doing it several times. All clear tints are reproduced much quicker and better than deep colors; that is, the nearer they approach to white, the more easily are they reproduced, and the nearer they approach to black, the more difficult is it to reproduce them. This, indeed, might be foreseen, since the more luminous the colors, the greater is their photographic action. Bodies that best reflect white light are those also which are the best reproduced; consequently, white light, so far from hindering the reproduction of colors, renders it, on the contrary, much easier, as has just been shown. Having observed that clear and shining tints are reproduced a great deal better than deep thick colors, provided the first be not exposed to the direct rays of the sun—in which case they reflect the light like a mirror, and reverse the image in particular parts—I tried the effect of operating through a camera with the lightest interior possible, and for that purpose had one lined inside with white paper. The results, so far as regards their production of colors—which it was the end and object of my experiments to demonstrate—were at least equal to those obtained from the black camera. I then tried a camera lined inside with glass inlaid with tin, and still obtained the same results, although such

a camera is contrary to all received photographic rules. Nevertheless, I have not been able to assure myself, positively, whether it is really an advantage to use these two descriptions of camera in preference to any others for the purpose of producing powerful effects and for rapidity of operating, because the means I have used have not thus far allowed me to make my comparative experiments with sufficiently exact calculations. Inasmuch as light colors are reproduced more easily, and especially more promptly than deep colors, it is important that the tints of the sitter's dress be nearly of the same tone, that is, when it is desirable to obtain them all at once; otherwise, the clear tints will pass the just point before the dark ones can come up to it. Still, colors of different tones can be obtained simultaneously, by taking the precaution to have the deep colors of a brilliant or glossy appearance, which I have practised with success. The most difficult color to obtain along with the others is deep green, like that of foliage, for the reason that green rays have but little photogenic action, being almost as inert as black itself; nevertheless, light green is very well reproduced, especially if it be brilliant, as, for instance, green glazed paper. To obtain deep green, the plate should be scarcely warmed before exposing it to the light, whilst for most other colors, especially fine white, it is necessary, as I have stated on a former occasion, that the sensitive coating be brought by the heat of a spirit lamp to a cherry-red. But this red tint has its inconveniences, causing the blacks and dark shades to remain almost red; however, it does sometimes happen that even the blacks are very well indicated, particularly when the operation is by contact. I have tried by all the means at present in my power, to dispense with this preparation, by raising the temperature, but have not yet found it to be possible. It was by the following experiments that I have been put on the track which I confidently hope will conduct me to a complete solution of the problem of heliochromy.

"If on taking the plate from the bath, it be just dried, without raising the temperature to the point of changing the color, and in this state if it be covered with a colored engraving and exposed to the light for a very short time, the engraving will be reproduced with all its colors; but in a majority of cases the colors are not visible; it is only some few of them that will appear, when the exposure to the light has been sufficiently prolonged; these are the greens, the reds, and sometimes the blues; several of the other colors, and frequently all of them, although certainly produced, still remain in a latent state, which is proved as follows: Take the pledget of cotton impregnated with ammonia which had served to clean the plate, and rub the plate gently with it, when you will very soon see the image appear, little by little, with all the colors. In order to do this, you must remove the outside film of the chloride of silver, so as to reach the deeper undercoating which adheres immediately to the silver plate and on which the image is formed. From this it will be seen that it only remains now to find some substance that shall develop the image, and which may perhaps at the same time fix the colors. This accomplished, the great problem will be entirely solved. In the course of my multiplied researches, made to this end, I have remarked that when the vapor of mercury is employed, the image, although very well developed, will be of a uniform gray tone, without any trace of color; this image although differing in appearance from the daguerrean image, is yet like it in one respect; it shows a positive image in one point of view and negative in another. A weak solution of gallic acid, with the addition of a few drops of ammonia, will equally cause the image to appear, especially if the plate be a little warmed, and then dried without washing. The image which then appears will be quite similar to that produced by mercury; but, if to the gallic acid a few drops of aceto-nitrate of silver be added, it becomes almost black.

"The time of exposure necessary for the production of the colors varies considerably according to the preparations of the plate; but I have much abridged the time, having obtained proofs in the sun, with a German camera, upon a half-size plate in less than a quarter of an hour, and in diffused light in less than an hour. Although it is true that the more sensitive the plate, the more rapidly do the colors come out, yet, thus far, I have not been able to obtain them in a moment; the question of permanent fixation remains to be solved, and as I have above suggested, this may perhaps be connected with that of finding out some substance that shall de-

velop the latent image. Although much still remains to be accomplished, yet the results that I have already obtained are, I think, truly extraordinary. The specimen proofs of my doll, where the model of the figure with the colors of the vestments were all represented with great clearness, and the gold and silver galoon with their true metallic lustre were also reproduced with great brilliancy, have excited the lively astonishment of those to whom I have shown them. These proofs have already realized, in part at least, the enthusiastic hopes of my late uncle, who used to say to one of his friends, the Marquis of Jouffroy, that the day would come when he could reproduce his image precisely as he saw it in the mirror."

M. E. Becquerel, of Paris, also succeeded by another series of experiments, differing materially from those of M. Niépce de St. Victor, in obtaining the natural colors by photography. M. Becquerel takes a well-polished silver plate, and after covering the back of it with varnish so as to leave the front surface alone exposed, he attaches it by copper hooks to the positive conductor of a voltaic battery of one or two cells; to the negative conductor of the battery is attached a piece of platinum. The plate of silver and the platinum are then plunged into a mixture of 8 parts of water and 1 part of hydrochloric acid. The electric current decomposes the acid and causes a deposit of chlorine on the surface of the silver, while hydrogen is liberated at the negative pole. The chlorine gas unites with the silver and forms a violet-tinted coating which would become quite black if the operation were continued a sufficient length of time. This coating is tolerably sensitive to light when very thin, and in that condition produces the natural tints, although these are very weak. By increasing the thickness of the layer the tints become much brighter, but the sensitiveness diminishes. In order to ascertain exactly the amount of chlorine deposited on the silver plate, M. Becquerel introduces into the voltaic circuit an apparatus for the decomposition of water; and since chemical decomposition is similar in quantity for each cell of a battery, by measuring the amount of hydrogen produced by this decomposition the quantity of chlorine liberated on the surface of the silver plate is easily arrived at, which, for the best results, is about 0.0004 of an inch in thickness. Before exposure to the spectrum the surface has a pale wood color; but if it be heated to between 150° and 200° Cent. (300 to 390 F.), it becomes rose-colored on cooling. If, however, instead of raising the heat to a high temperature, it be closed within a copper box and gently warmed, say from 90° to 95° F., and maintained at this heat for five or six days, or, better still, placed in a frame covered with a deep-red glass, and exposed to the sun's rays for from a quarter to half an hour, on being submitted to the action of the prismatic spectrum the natural colors appear in all their beauty, and the green and yellow tints which previously were obtained with difficulty are now brightly and clearly defined.

In the ordinary collodion positives on glass we occasionally meet with examples of partial natural coloring; the green and red of foliage, and the red of brick houses have often been reproduced on the collodion plate in tolerably well-marked colors. Mr. Shadbolt thinks that, as a basis to experiment, we should study the photographic coloring of Nature, and endeavor to ascertain how we can in any degree copy the colors. Ever since the discovery of M. Niépce de St. Victor, we have indulged the idea that that process *combined* with that of Becquerel was to solve the mystery.—*H. H. Snelling.*

Heliochromoscope. An ingenious instrument invented by F. E. Ives, wherein the triple images obtained by his heliochromic process may be viewed as one picture, representing the object photographed in its natural colors.

Heliochromy. Photographing in natural colors, without applying colors by hand or in any other mechanical way. Such pictures have been attempted in the chemical way (by silver subchlorides), in the physical way (by action of interference in the interior of the film), and in the optical way (by the projection of three diapositives, corresponding to the foundation colors, with the help of corresponding colored media).

Heliograph. An instrument for numerically registering the intensity of the incident beam; invented by M. Jordan.

Heliography. The first photographic process devised by Niépce, for obtaining an image on stone or zinc by the use of bitumen of Judea, was called by him *heliography.* The name is now used to signify all methods of reproducing subjects in lines or dots. The

photogravure process is of this class. It is a process of transferring photographs on copper plates, etching with acid, and printing in the copper printing press. Such pictures resemble copper engravings. This is the finest but most expensive of the photo-mechanical processes.

Heliographic Damaskeening. A process discovered by M. Dufresne. With the voltaic pile cover with a first coat of copper the surface of the metal you wish damaskeened, say silver; spread over it a coat of nickel, antimony, iron, or any unamalgamable metal, then cover it with another coat of copper, on which you operate photographically with the bichromate of potash. Nearly all photographic processes answer for this damaskeening, provided they retain sufficient resistance to the action of acids, with which you take off the copper. You then coat this plate with a solution of bichromate of potash, and when dry, print upon it with a negative or glass positive, according to the results you wish to obtain; afterward washing off the unchanged bichromate. The copper surrounding the image or unaffected by the light is then removed by dilute nitric or sulphuric acid, which leaves an arabesque of copper on an unamalgamable bottom. Gild by the fire process, and then destroy the unamalgamable coat with an acid which has no effect upon gold; and when you reach the first copper coat dissolve it out with cold aqua ammoniæ, which will not affect the silver.

Heliographic Engraving. The name given by M. Niépce de St. Victor to his processes for engraving, by the help of photography, on glass, stone or steel. The processes are: 1. *By contact with a negative;* 2. *By direct action in the camera.*

Heliotype. A modification of the *collotype* process, which see.

Helypsometer. A photographic instrument for determining latitude at sea; invented by Mr. J. Oakes. It is a hollow brass hemisphere, about 10 inches in diameter, silvered on the inside and suspended in gimbals like the ordinary ship's compass; the hemisphere has a closely fitting cover, pierced at its centre by a small round hole; the apparatus is mounted on a foot or base. To prepare it for use the concave surface is coated, in the dark, with the vapor of iodine, which makes a surface sensitive to light. The cover is then adjusted, and the instrument placed in the sunlight. The sun's rays passing through the aperture in the cover trace his path in the heavens, on the concave of the hemisphere. By applying a circular protractor after the exposure, the sun's altitude is readily found in degrees and minutes. Any motion of the hemisphere in the gimbals is easily corrected; if it swing in one direction so as to represent too great an altitude, it swings equally in the opposite direction, and it is only necessary to make an average of mean measurement with the protractor.

Hepworth's Four-Poster. For use in the dark-room for various purposes. The accompanying sketch of the erection is given by Mr. T. C. Hepworth. "The four posts

FIG. 114.

are six feet long and one inch and a half square. The first operation is to place these posts in pairs, and mark upon them lines indicating the places where the supports for the shelves are to be screwed. The intervals between these supports must be according to the size of the plates which are to stand upon the finished structure. My shelves are placed at different distances, so as to accommodate different sized plates. The supports, two feet long, and made of stuff one inch by three-quarters of an inch thick, are now screwed into their places, when the pair of posts have the appearance of two ladders. The shelves

must now be taken in hand, and are conveniently made before being put into position. They are made of laths, about one inch by three-eighths of an inch, which can be bought by the dozen at any sawmill. These can be carefully measured off with pencil-marks, the upper laths being spaced out according to the size of the plates which are to stand upon them, the lower ones being intended for the top edge of the leaning plates to rest upon. At each point of crossing, the junction must be made by one French wire nail. When the shelves are all in position, the general structure can be screwed together with tie-pieces, the back and sides filled in with black glazed calico, and a blind of the same material fitted to a roller in front. In my four-poster, a closed gas stove is fitted to the lower part; but this is not necessary for gelatine plates, which will soon dry if the room itself be not damp. The skeleton arrangement of the shelves permits a constant current of air to circulate round about the plates; but a better current can be insured by taking advantage of the rising property of warm air, in a manner first suggested by myself in the *Photographic News*."

Hermetical Closing. Closed up air-tight.

High Lights. Those portions of the picture which are brighter than the rest of the image; high lights give brilliancy and relief to portraits and landscapes.

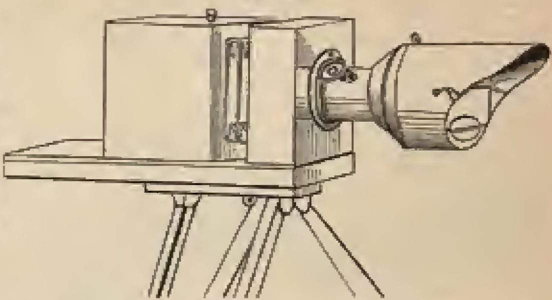
Hillotype. The name given to an alleged process for taking daguerrotypes in the colors of Nature, "discovered" by Mr. L. L. Hill.

Holes in Collodion Film. These annoying little imperfections frequently occur during manipulation, and are generally caused by particles of various kinds floating in the nitrate bath; in fact, this is always the cause, except where the bath is too acid. The remedy is to filter the bath, and to churn the plate well while immersed in it; or to neutralize the bath.

Honey Process. A negative dry process in which honey is used as the preservative solution. Honey is used as a preservative in the dusting-in process likewise.

Hood. For protecting the lens from extraneous light and for convenience in making the exposure. It is the device of Mr. Frank Thomas. It is so constructed that the rack and pinion of the lens and the central stops may be used without removing the hood from the lens. It is supplied with a shutter which is simply hinged to it, and a rubber band attached serves as a spring. See Fig. 115.

FIG. 115.



Horn Silver. Kerate chloride of silver; fused white chloride of silver.

Hot Varnishes. (See *Varnishes.*)

Hot-Water Bath. Consisting of a vessel containing the solvent and the substance to be dissolved, which vessel is placed into a larger one containing water, kept boiling till the substance in the smaller vessel is dissolved.

Hot-Water Cabinet. A device invented by Mr. J. G. Tunny, made of metal, for the

FIG. 116.

purpose of keeping photographic solutions warm. The vessel is filled with hot water and the bottles, beakers, etc., are placed

therein. A thermometer is a convenient attachment.

Hot-Water Process. This is simply the application of hot water to collodio-albumen plates to coagulate the albumen and render the plate more sensitive. After sensitizing the albumen coating, the plate is plunged into water just below the boiling-point for a few seconds, and finished in the usual way. This gives dry plates of great sensitiveness. The discovery is due to John Ryley, M.D.

Hough's Transfer Process. Take the picture on the smoothest plate glass, and when dry give it a coat of collodion varnish; dry again and repeat. Then flow it with a solution of asphaltum and gutta-percha in chloroform, quite fluid and perfectly free from sediment or undissolved particles. When dry, flow again with collodion, and immediately place in contact a firm, strong tissue paper the required size, which becomes, as it were, a part of the picture itself. All this is done in a very short time. Then place it in a dish of cold water—the colder the better. In a few minutes it is loosened entirely, as pliable as photograph paper, and as brilliant in tone as any collodion picture can be. In all cases where you wish to preserve a picture on glass, not reversed as an ambrotype view, varnish with two coats of collodion, then with black varnish, and the whites are perfectly preserved.

Hungarian Liquid. An accelerating substance used in daguerrotypy.

Hyalotype. A name originally applied to photographs upon albumenized glass. The peculiar process to which it was applied was invented by Messrs. Langenheim and Beckers, of Philadelphia.

Hydracid Salts of Silver. By the term "hydracid" is meant those salts of silver which do not contain oxygen, or oxygen-acids, but imply elements like chlorine or iodine combined with silver. These same elements are characterized by forming acids with hydrogen, which acids are hence called "hydracids." Hydrochloric acid (HCl) and hydriodic acid (HI) are examples. (See *Reduction.*)

Hydrate. A compound containing water in definite proportions; thus, slaked lime is a hydrate of lime, caustic potassa is a hydrate of potassa.

Hydriodate. A compound formed of hydriodic acid with a base. The hydriodates may be easily formed by saturating the acid with the oxides or hydrates of the bases. A list of such compounds may be found in standard works on chemistry.

Hydriodic Acid. HI. Combination of equal parts of hydrogen and iodine; very acid, colorless, fuming gas, very soluble in water.

Hydrobromic Acid. An acid compound of hydrogen and bromine. It may be prepared by mixing the vapor of bromine with hydriodic acid and sulphuretted hydrogen or phosphoretted hydrogen gas; decomposition ensues and hydrobromic acid is generated. Or it may be prepared by decomposing bromide of barium with sulphuric acid, when pure hydrobromic acid will be evolved. It should either be collected in dry glass bottles, in the manner directed for chlorine, or over mercury in the pneumatic trough. When passed into water it forms liquid hydrobromic acid. With nitric acid it has the property of dissolving gold. Hydrobromic acid is highly sensitive to light and must be kept in a perfectly air-tight bottle, and not exposed to sunlight.

Hydrochlorate. A compound of hydrochloric (muriatic) acid with a base.

Hydrochlorate of Ammonia. This salt is prepared by mixing an excess of ammonia with hydrochloric acid; it is then evaporated by gentle heat and left to crystallize. It is very soluble in alcohol. Advantage can be taken of this property to prepare the photographic paper, first with albumen simply; then, the albumen being dry, place the albumen side in a bath of alcohol at 36° containing 5 per cent. hydrochlorate of ammonia. The alcohol congeals the albumen and this dispenses with the necessity of passing a hot iron over it. This salt attracts much more moisture from the atmosphere than the chloride of sodium, and this property renders it much to be preferred for the preparation of positive paper. Hydrochlorate of ammonia is also used for intensifying negatives. Make a solution of

Bichloride of Mercury	1 grain.
Hydrochlorate of Ammonia	1 "
Water	20 grains.

and pour it over the plate *after fixing.* As soon as the image assumes a rich cream color, wash the plate thoroughly and pour over a weak solution of ammonia (1 grain to 10 of water) or hypo. This can be used repeatedly without filtering.

Hydrochloric Acid. HCl. Muriatic acid. Strong acid. Pure aqueous hydrochloric acid is colorless, the raw article, however, more or less yellow. Serves in the production of many chlorides of metals. In a diluted state it is used for the precipitation of silver from silver chloride and for fixing platinum prints.

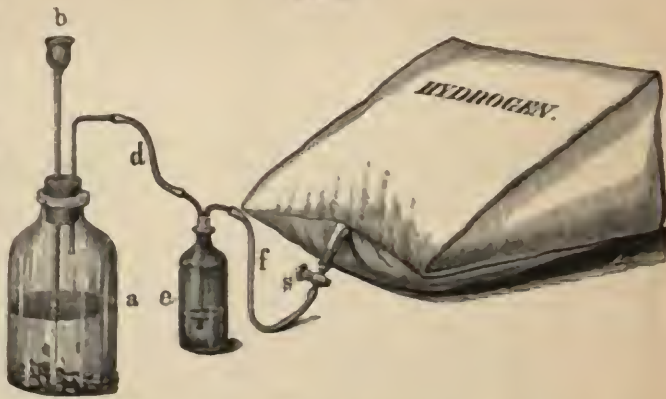
Hydrochloric Ether. A combination of chloric acid, hydrogen, and ether. Used as a solvent of the silver and applied without any saline wash, it has a similar property to nitric ether; but as it is readily acted on by faint light it is of greater value. Papers prepared with it must be used within twenty-four hours, as after that they quickly lose their sensitiveness and then become nearly useless. (See *Mordant Washes.*)

Hydrocyanic Acid Soap. Soap containing cyanide of potassium, used for removing silver spots.

Hydrofluoric Acid. An acid compound of hydrogen and fluorine. To prepare it, pour concentrated sulphuric acid on half its weight of fluor-spar, carefully separated from silicious earth and reduced to fine powder. The mixture must be made in a capacious *leaden* retort, and a gentle heat applied. Collect in a leaden receiver surrounded with ice. This acid acts as an accelerator when mixed in small proportions with bromine or bromide of lime. It, however, cauterizes glass and is extremely detrimental to the lenses of the camera, and as it is no improvement to the daguerrotype it should not be used. It is also used for etching the glass in the various processes for engraving upon glass. (See *Photographic Engraving on Glass.*)

Hydrogen. H. Very light, combustible gas, which, if mixed with oxygen or atmospheric air and ignited, explodes with great force. Used in the preparation of lime-light (*q. v.*). The manufacture of hydrogen is shown in Fig. 117. In the bottle, a, sulphuric acid and zinc filings are placed. The air-vent is at b. When the action begins, the gas passes from the bottle through the tube d into the wash-bottle e, and from the latter through the pipe f into the rubber bag, which expands as the supply is received; s is a stopcock.

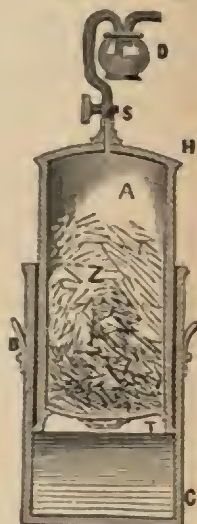
Fig. 117.



Hydrogen Gasometer. The first figure is an exterior view; the second shows the

Fig. 118.

Fig. 119.



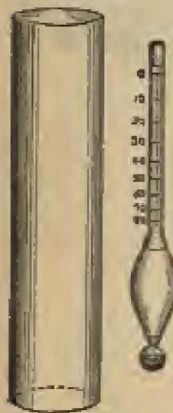
operation of gas-making going on. A is the interior filled with zinc filings or scraps. S

is the stopcock. D is the wash-bottle. The bottom, A, is perforated, and the whole is lowered into the sulphuric acid at T. The gasometer is made of copper with handles, B, at the sides.

Hydrogen Peroxide. Syn., Peroxide of hydrogen; hydroxyl. A colorless, neutral liquid, possessing a metallic taste and liberating oxygen on being gently warmed. Used to test iodides in presence of bromides or chlorides. Also proposed as a "hypo" eliminator on account of its energetic oxidizing action.

Hydrometer. For testing the specific gravity of gold and silver solutions and other liquids. The solution is placed in a glass jar or tube, while the scale is allowed to drop into the solution. As different mixtures vary in density, allowance must sometimes be made. A table of corrections is supplied by the manufacturers to assist the photographer in making his calculation. (See Fig. 120.)

FIG. 120.



Hydrophosphorous Acid. This acid is prepared by digesting in water the phosphuret of barytes, when phosphate of barytes and hyposulphate of barytes are formed; the former is insoluble, the latter soluble. Separate by filtration. The barytes is then to be separated by sulphuric acid, and the hydrophosphorous acid is held in solution. When its solution is concentrated by evaporation it has the property of deoxidating several substances, and precipitating many metals in the metallic form.

Hydroquinone. Syn., Quinol, hydrokinone, hydrochinon. A derivative of chinon, closely allied to pyrogallol in composition, having the formula $C_6H_4(OH)_2$. Hydroquinone was suggested as a developing agent by Abney in 1880, having been known to chemists for some years; its general use as a developer, however, is comparatively recent. It comes commercially in the form of yellow needle-like prisms, soluble in water, ether, and alcohol. The developing action of hydroquinone is much slower than pyro, but on account of its constant reducing power, much more effective. Its use is recommended for negatives, transparencies, lantern slides, and bromide papers. In solution it keeps well, and gives, with either caustic or carbonated alkalies, images of a velvet-black color, fine in grain and clear in the shadows; it may be used repeatedly, the use of new solutions being advised for negatives.

The subjoined formula is recommended:

1. Carbonate of Soda	60 grains.
Water	1 ounce.
2. Hydroquinone	12 grains.
Sulphite of Soda (cryst.)	60 grains.
Water	1 ounce.

For use, take of

No. 1	1 ounce.
No. 2	2 ounces.
Water	1 ounce.

The water is added either warm or iced, according to the season; the image makes its appearance in two or three minutes; development proceeds rapidly and is completed in five or six minutes. In developing with hydroquinone scrupulously clean dishes are essential to avoid stains. To prevent negatives having too strong contrasts the addition of 60 drops of a 10 per cent. solution of ferrocyanide of potassium to each ounce of developer is recommended.

Hydrosulphate of Ammonia. The liquid known by this name, and formed by passing sulphuretted hydrogen gas into ammonia, is a double sulphuret of hydrogen and ammonium. In the preparation, the passage of gas is to be continued until the solution gives no precipitate with sulphate of magnesia, and smells strongly of hydrosulphuric acid. It is colorless at first, but afterward changes to yellow, from liberation and subsequent solution of sulphur; becomes milky on the addition of any acid; precipitates, in the form of sulphuret, all the metals which are affected by sulphurretted hydrogen, and, in addition, those of the class to which iron, zinc, and manganese belong. Hydrosulphate of ammonia is employed in photography to darken the negative image, and also in the preparation of iodide of ammonium, the separation of silver from hyposulphite solutions, etc.

Hydrosulphuric Acid. This substance, also known as sulphuretted hydrogen, is a

gaseous compound of sulphur and hydrogen, analogous in composition to hydrochloric and hydriodic acids. It is usually prepared by the action of dilute sulphuric acid upon sulphuret of iron. Fit a cork and flexible tube into the neck of a pint bottle; introduce as much sulphuret of iron as will stand in the palm of the hand, and pour upon it 1½ fluidounces of oil of vitriol diluted with 10 ounces of water. The gas is generated gradually without the aid of heat, and must be allowed to bubble up through water in a glass receiver. The smell of sulphuretted hydrogen being offensive and highly poisonous if inhaled in a concentrated form, the operation must be conducted in the open air or in a place where the fumes may escape without doing injury. Cold water absorbs three times its bulk of hydrosulphuric acid, and acquires the peculiar putrid odor and poisonous qualities of the gas. The solution is faintly acid to test-paper, and becomes opalescent on keeping, from gradual separation of sulphur. It is decomposed by nitric acid, and also by chlorine and iodine. It precipitates silver from its solutions in the form of black sulphuret of silver; also copper, mercury, lead, etc., but iron and other metals of that class are not affected if the liquid contains free acid.

Hydrotype. A reversed collotype, secured by a method made known by M. Cros, in 1893, but first made public in 1879.

Hydroxylamine. A substance having the formula NH_3O, known for some years as a reducing agent, but only recently introduced as a developer. The chlorhydrate of hydroxylamine is generally used in the form of tabular, colorless crystals. The following formula gives good results with almost all kinds of bromide emulsion plates:

1.	Alcohol	4 ounces.
	Hydroxylamine	2 drachms.
2.	Water	4 ounces.
	Caustic Soda	4 drachms.
3.	Potassium Bromide	50 grains.
	Water	3 ounces.

For use take 1 drachm each of 1 and 2, mix with half a drachm of 3 to each ounce of water. Hydroxylamine may be used repeatedly, although the first plates developed are generally better than the last; it may be employed in the development of negatives, chloride emulsion plates, and bromide papers.

Hygiene in Photography. The matter of hygiene in photographic work does not receive the consideration it deserves. Ventilation, the avoidance of bad odors and close rooms, and general attention to cleanliness, all have their proper relation to the good of the photographer.

Hygroscopic. Applied to bodies which absorb moisture from the air; for instance, chloride of calcium, concentrated sulphuric acid, honey, glycerine, sugar, carbonate of potash, caustic potash, burnt lime, etc.

Hypochlorate of Potash. This product is found abundantly in commerce, and is obtained on this large scale by passing chlorine through a cold solution of carbonate of potash. This solution, diluted with as much again of water, perfectly destroys the tints which spot the paper; it also fixes the proof perfectly, and imparts very agreeable tones. The hypochlorite of lime produces the same effect. We consequently obtain by these two bodies proofs in which the lights are well preserved.

Hyposulphite of Soda. Hypo; thiosulphate of sodium; antichlor. $Na_2S_2O_3+5H_2O$. Large, colorless crystals, very soluble in water. Used for fixing negatives and positives; a small amount added to the iron developer quickens it.

Hyposulphite of Soda and Gold. $Au_2S_2O_3+3Na_2S_2O_3+4H_2O$. A double salt of hyposulphite of gold and soda. Is formed by adding chloride of gold to a hyposulphite of soda solution, and mixing with it alcohol, when it will crystallize out in fine needles, very soluble in water. Used in the toning bath for positive prints.

I.

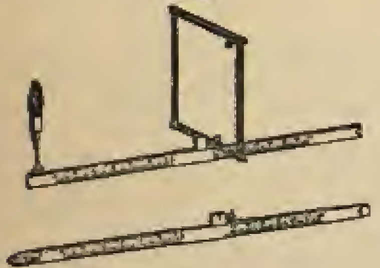
Iceland Moss. A species of lichen found in Iceland and the mountainous parts of Europe; when boiled in water, it first swells up and then yields a substance which gelatinizes on cooling. Plain paper may be prepared with Iceland moss as follows:

Chloride of Ammonium or Soda	160 grains.
Purified Gelatine	20 "
Iceland Moss	60 "
Water	20 ounces.

Pour boiling water upon the moss and gelatine and stir until the latter is dissolved, then cover the vessel and set aside until cold; add the salt, and strain.

Iconometer. View-meter; a pocket instrument which quickly indicates what kind of objective to use in order to take a picture of a certain size from a given standpoint, or to ascertain the standpoint suitable for a view with a given objective. The figure illustrates one which consists of a hollow, four-cornered, nickel plated brass pipe, about 20 centimetres in length, one side of which

FIG. 121.



is provided with a millimetre scale. A slide runs along the tube, into which the frame, made out of watch-steel spring, is screwed. At the end of the tube, the zero point of the scale is fixed. The application is the same as in all similar instruments. The special beauty of this one is that it can be closed up. The frame and the dioptre find their places inside the tube, and the whole apparatus can be put into the coat-pocket, just like a lead-pencil.

Illuminating-Box. An invention of Captain Himly, of Berlin, for supplying artificial light by means of incandescent lamps. The first great desideratum is a perfectly even surface of illumination. This is obtained on the following principle: A metal box of special form is both screen and reflector. Inside of this box (Fig. 122) two lamps are placed at a and a'. The reflectors b and b' throw all the light on the back of the box from e to g. The only opening through which the light can get out is between the screens f and f'. These two screens also allow no particle of direct light to pass out of the box. The interior of the box is painted dull white. As a result of this arrangement the source of illumination is an evenly lighted surface of indirect rays. The only light that can fall upon the subject comes from this surface. This scheme can be improved in many ways. The best form for the box is one resembling a broadened parabola (Fig. 122). This saves a large amount

FIG. 122.

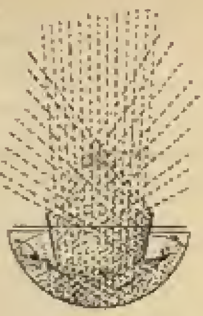


FIG. 123.

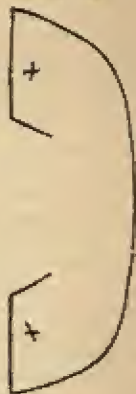


FIG. 124.

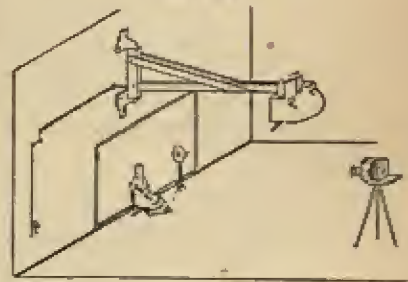
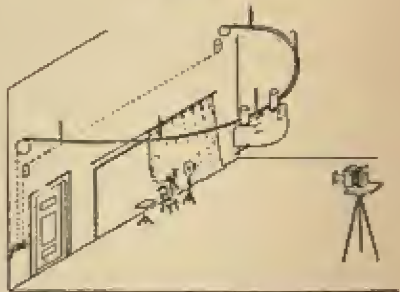


FIG. 125.



of the side rays. Moreover, the bottom should be movable, in order to let the light reach farther downward when desirable.

The illuminating-box is placed either at the end of a long swinging arm (Fig. 124) or on a horizontal rod which can be bent so as to bring it to any desired position (Fig. 125). By this means it can be moved at any desired rate, from one side to the other, stopping or going at will. The whole construction is simple and inexpensive. The kinds of light that can be used are: (1) gaslight; (2) electric light; (3) magnesium light; (4) pyrotechnic light. With gaslight, two strong lamps are placed in the box; if the products of combustion are annoying, they can be conducted through a tube along the arm to a chimney. Best of all is the electric light.

Image. (See *Photographic Image.*)

Image, Latent. When a sensitive dry plate is exposed to the influence of light, the sensitive surface undergoes a change, the exact nature of which has not yet been made plain. By this change the image before the lens is impressed upon the plate, but is invisible, being called the latent (or hidden) image. It is made plainly visible by the application of developing agents suited to the composition of the surface. There are two theories held as to the nature of the latent image, one being chemical, the other physical. If the *chemical* theory is correct the effect produced on the plate is that the bromide of silver in the film is reduced to a sub-bromide. By the ordinary exposure given to dry plates the reduced molecules of silver sub-bromide are too few in number to form a visible image, hence a latent image results. According to the *physical* theory the action of light is to produce a change in the film, destroying the equilibrium previously existing, and rendering it possible to make the image impressed in the film visible by development.

The exact nature of the invisible (or latent) image, however, has little practical bearing upon the development of the image. It is sufficient to know that a change is produced by light, and can be made permanent.

Imitation Ground-Glass. This is made by spreading a solution of gum tragacanth dissolved in the white of eggs upon glass with a brush; or using skimmed milk in the same manner. Skylights, windows, and sash doors may be made impervious to external eyesight and glaring sunlight by the first coating, while the last answers for the focussing-glass of the camera.

Imperfections in Collodion Negatives. These are *fogging* (see *Fogging*); *spots* of various kinds, which are caused by the use of collodion holding small particles in suspension; turbidity of the nitrate bath; dust on the surface of the glass at the time of pouring on the collodion; from small holes in the slide admitting a pencil of light; insoluble particles in the pyrogallic acid; causes which render the iodide of silver insensible to light at particular points, making a transparent spot; concentration of the nitrate of silver on the surface of the film by evaporation; small particles of undissolved iodide in the collodion; the alcohol or the ether containing too much water, and the use of glass improperly cleansed. (See *Spots.*)

Markings, which are also divided into a variety of kinds, viz.: *A reticulated appearance on the film after developing*, often caused by using collodion containing water, or by immersing the plate too quickly in the bath, partially precipitating the soluble pyroxylin; *oily spots or lines*, from raising the plate out of the nitrate bath before it has been immersed sufficiently long to become sufficiently wetted, or from removing it before the ether on the surface has been washed away, or from re-dipping the plate after exposure to light, and pouring the developer on immediately, or from the nitrate bath being covered by an oily scum; *straight lines traversing the film horizontally*, from a check having been made in immersing the plate in the bath; *curved lines*, from employing the developer too strong, or not pouring it over sufficiently quick, or by using too little acetic acid and omitting the alcohol; *stains*, from too small a quantity of fluid having been employed to develop the image: *irregular striæ*, from fragments of dried collodion accumulating in the neck of the bottle, and being washed on the film; *wave-like markings*, caused by using an inferior pyroxylin, and most seen when using an old bath; *stains on the upper part of the plate*, from using a dirty slide; *wavy marks at the lower part of the plate*, from the collodion being too thick and glutinous, from reversing the direction of the plate after its removal from the bath, or from impurities on the woodwork of the frame ascending the film from capillary attraction; *marks* from the developer not running up to the edge of the film, from the film not having set sufficiently. *A want of intensity*, from the development not having

been sufficiently pushed, from the collodion film being too blue and transparent, or the collodion being too new, or the plate having been kept too long between exciting and development, or the bath having been newly prepared from impure nitrate, or the light was too feeble; *inferior half-tones with great intensity of the high lights*, from the plate being insufficiently exposed, the collodion of inferior quality, the nitrate bath old and partially decomposed, or the light is reflected too strongly from the object; *the image pale and misty*, from over-exposure, or there is diffused light in the camera or developing-room, or from the presence of bromides or chlorides in the collodion; *the high lights of the image are solarized* from over-exposure of the plate, organic decomposition of the collodion, or from acetate of silver and other organic bodies in the bath; *the image dissolves off on applying the fixing agent*, from the collodion being over-iodized; *the developer does not run up to the edge of the plate*, from using collodion nearly anhydrous, and the nitrate bath is new and contains very little alcohol; *the film peels off*, from the glass not being clean and the collodion too thick.

Imperfections in Collodion Positives. Besides those common to both negative and positive, as above described, we have several peculiar to the latter. *The shadows are dark and heavy*, from the plate not having received sufficient exposure in the camera, or from the film being very transparent and the silver solution weak, or nitric acid is present in the bath, or the collodion is brown from free iodine; *the shadows good, but the lights overdone*, in consequence of the developer having been kept too long, or the object is not properly illuminated, or the collodion is not adapted for positives; *the high lights are pale and flat, the shadows misty*, from over-exposure in the camera; *the picture develops slowly and spangles of metallic silver are formed*, from too much nitric acid being present in proportion to the strength of the bath, to the amount of iodine in the film, and to the quantity of protosalt in the developer; *circular black spots after backing up with the varnish*, caused by lifting the plate too quickly out of the bath, or by pouring on the developer at one spot, or by the use of the glasses imperfectly cleaned; *the image becomes metallic on drying*, from the developer (of iron) being too weak, or free nitric acid has been added in excess, or the proportion of nitric acid is too great in the (pyrogallic) developer; *green or blue tints in certain parts of the image*, from the deposit of silver being too scanty, in consequence of the over-action of light, or the film of pyroxylin being too thin; *vertical lines and mistiness on the image*, from using an old bath much reduced in strength, by the loss of nitrate of silver and want of alcohol in the developer.

Imperfections in Paper Prints. These are: *Markings of the brush*, from an excess of ammonia in the nitrate solution; *the prints are marbled and spotty*, from inferior quality of paper which does not imbibe the liquids evenly, or the amount of nitrate of silver in the sensitizing solution is not sufficient; *the prints are clean on the surface, but spotted when held up to the light*, owing to imperfect fixation; *the print is pale, cold, and faded in appearance*, from the chloride of silver in the paper being in excess with regard to the free nitrate of silver, or from using a too weak solution of nitrate of silver, or from the paper having been kept too long after sensitizing; *the high lights are of a yellowish cast*, from acidity of the toning bath, from over-toning, from allowing the bath to remain idle too long and decomposing, or the paper is kept too long, or the washing is imperfectly done, or too prolonged, from exposing the print to light during toning and fixing, or from too long a time being allowed to elapse between printing and fixing; *intense bronzing of the deep shadows*, from too great transparency in the negative, and the paper being salted too strong to correspond with the weakness of the negative; *imperfect definition*, from bad paper if the negative is a good one; *yellow markings over the shadows*, from carelessness in handling the paper, washing in unclean dishes, or laying them down or together while damp; *small specks and spots of different kinds*, from black spots or pin-holes in the negative, from metallic specks in the paper, from insoluble particles floating in the bath, or from coming in contact with cyanide of potassium, or sulphuret or ammonia, etc.; *marbled stains on the surface of the print*, from allowing the silver solution to stand in the dish unused some time without filtering; *streaks on albumen paper*, from uneven coating with silver solution, and the albumen does not wet readily; *the albumen flakes off the paper*, from the bath being alkaline.

Impurities in Photographic Chemicals, and Tests for Same. By G. M. Jones, M.P.S.

Substance.	Impurities possibly present.	Tests.
Ammonia, NH_3 . . . Molecular weight, 17	Carbonic acid . . .	Renders lime-water milky.
	Dissolved solid matter .	Residue left on evaporation.
	Chlorides	After acidulating with nitric acid it gives a precipitate with silver nitrate, which, after washing, is readily soluble in ammonia and reprecipitated by nitric acid.
	Sulphates	After acidulating with nitric acid it gives a precipitate with barium nitrate.
	Lime	A white precipitate with oxalate of ammonium.
	Lead is often present, derived from the action upon flint glass bottles.	Black precipitate with sulphuretted hydrogen.
Nitric Acid, H,NO_3 . . Molecular weight, 63	Traces of sulphuric acid .	After dilution it gives a precipitate with barium nitrate.
	Chlorides	After dilution it gives a precipitate with silver nitrate.
	Peroxide of nitrogen . .	The acid is yellow.
	Iodine may be present if the acid be prepared from sodium nitrate.	After dilution and cooling it gives a blue color with starch, paste, or mucilage.
Hydrochloric Acid, HCl . Molecular weight, 36.5	Free chlorine . . .	Liberates iodine from solution of potassium iodide. See also "Chlorides," nitric acid.
	Sulphuric acid . . .	As above for nitric acid.
	Perchloride of iron . .	Yellow color. Brown precipitate with ammonia added till it smells slightly.
Sulphuric Acid, H_2SO_4 . Molecular weight, 98	Bisulphate of potassium .	Residue on evaporation.
	Sulphate of lead . . .	Milkiness on dilution. May be completely freed from lead by diluting with three or four times as much water, and allowing to settle.
Acetic Acid (glacial) $H,C_2H_3O_2$ Molecular weight, 60	Water	Does not solidify when cooled to 17° C. (53° F.).
	Sulphurous and hydrochloric acids.	White precipitates with silver nitrate.
	Aldehyde, or volatile tarry matter.	Blackens in the light after adding silver nitrate.
	Organic sulphuric acid .	Smell of garlic.
Citric Acid, $H_3C_6H_5O_7H_2O$. Molecular weight, 210	Tartaric acid . . .	Strong solution of potassium. Acetate added to a strong solution of the acid will deposit white crystalline bitartrate.
Pyrogallic Acid, $(C_6H_3)HO_3$ Molecular weight, 126	Metagallic acid . . .	Black residue, insoluble in water.
Silver Nitrate, $AgNO_3$. . Molecular weight, 170	Free nitric acid . . .	Reddens litmus paper. (Neutral silver nitrate does not affect litmus.)
Potassium Carbonate, K_2CO_3 Molecular weight, 138	Chlorides and sulphates .	Same as for ammonia.
Potassium Iodide, KI . . Molecular weight, 166	Potassium carbonate . .	A strong solution is alkaline to test-paper.
	Sulphates and chlorides .	Same as for ammonia.
	Potassium iodate . . .	A pretty strong solution becomes yellow from liberation of iodine on addition of dilute sulphuric acid, or, better, a strong solution of citric acid.
Potassium Bromide, KBr . Molecular weight, 119	Similar to potassium iodide	See potassium iodide.
Sodium Carbonate, Na_2CO_3 Molecular weight, 106	Chlorides and sulphates .	Same as for ammonia.
Sodium Chloride, NaCl . Molecular weight, 58.5	Chloride of calcium . . Chloride of magnesium .	Oxalate of ammonium (after adding a little acetic acid) gives a milkiness or precipitate indicating calcium; filter this out and add ammonia, chloride of ammonium, and phosphate of sodium (clear solutions). A precipitate indicates magnesium. Both the above cause dampness in wet weather.
	Sodium sulphate . . .	As for "sulphates" in ammonia.
Potassium Cyanide, KCN . Molecular weight, 65 and Hydrate, KHO Molecular weight, 56	Potassium carbonate nearly always present.	Effervescence with dilute acids, giving off a gas, carbonic anhydride, which renders lime-water turbid.

Substance.	Impurities possibly present.	Tests.
Kaolin	Chalk	Effervescence with dilute acids.
Water, H_2O Molecular weight, 18	Sulphates and chlorides	Same as for ammonia.
	Calcium carbonate, temporary hardness.	Deposited by boiling. Test as for calcium chloride. See Sodium Chloride.
	Ammonia, almost always present in distilled and rain water.	Brown coloration, or precipitate with Nessler's reagent.
Gelatine	Alum	Ash, sometimes as much as ten per cent.
	Fatty matter	Separated by precipitation with alcohol. Dissolved out by ether or benzene, and left as a residue on evaporation of the solvent.
Ammonium Bromide $(NH_4)Br$ Molecular weight, 98	Potassium bromide or other non-volatile bodies.	Leaves a residue when heated.
	Ammonium chloride	Same as for chlorides in ammonia.
Pyrogallic Acid	Powdered glass	Left behind on solution.
Potassium Iodide	Potassium bromide	The crystals of bromide are usually more transparent than those of iodide, but no reliance can be placed on this.
Silver Nitrate	Potassium nitrate, sometimes present in the fused sticks—not in the crystals.	Will not yield the full quantity of chloride on precipitation with HCl. Gives a purple color to flame.
Sulphuric Acid	When vended as pure, it invariably contains a trace of iron. Common acid is also liable to contain arsenic, selenium, thallium, and many other substances.	No easy test can be given, as the substances are so numerous, some of them volatile, and most require separation from the acid before detection.
	Organic matter, as a piece of straw in a carboy of acid.	Gives a brown color to the acid.
Hydrochloric Acid	Arsenic	Marsh's test.
	Some yellow samples contain no iron, but an organic salt, and give an alkaline ash on ignition of the residue after evaporation.	Reinsh's test; a small piece of copper foil becomes coated on boiling in dilute acid.
Calcium Chloride	Calcium hydrate	The clear filtered solution made with distilled water is alkaline to test-paper, and gives a precipitate on breathing into it through a tube.
Pure (?) chemicals generally	Broken glass, bits of straw, wool, paper, etc.	These impurities either float or sink on solution, and may easily be seen.

Incandescent Gaslight. Welsbach incandescent lamps; a gas-jet, invented by Dr. C. Auer v. Welsbach, requiring a Bunsen burner, allowing but a comparatively small stream of gas to pass, in connection with cotton saturated with substances obtained from rare earths or clays. This so-called stacking is brought to white-heat by the gas flame. The resulting very intense light is strong enough for photographic purposes.

Incidence, Angle of. When a ray of light passes a given point on any surface, the angle made by the ray with a perpendicular drawn to the surface at the point referred to, is the angle of incidence, which is identical with the angle of reflection.

India-Ink. A pigment consisting in the main of soap, tallow, wax, and any kind of gum or resin, also some coloring matter (usually lamp-black). Used for retouching prints and enlargements, also as coloring matter in carbon prints.

India-Ink Outlines. Prints made on plain salted paper, fixed without toning, then outlined with India-ink, and afterward bleached with bichloride of mercury until they have the appearance of ink sketches; are used by photo-engravers. (See *Bleaching Prints*, etc)

India-Rubber, or Caoutchouc. The dried juice of certain tropical plants. It is a compound of hydrogen and carbon. When pure it is white in color. It is used in photography, when dissolved in benzene, chloroform, or methylated ether, as a mountant, and occasionally as a substratum in certain dry processes.

India-Rubber Bath. A vessel made of

India-rubber to contain the silver solution for sensitizing.

India-Rubber Collodion. Collodion made with the milk of the rubber tree, sensitized in the usual way with iodide of ammonium and cadmium, and bromide of cadmium.

India-Rubber Solution. To make this, take 1 drachm caoutchouc, cut it up fine, and put it into a bottle, then pour upon it 12 ounces pure benzole (benzene) and set it by the fire, shaking occasionally until all the rubber is dissolved. If not thick enough to suit your purpose add more rubber, and be careful not to cork the bottle too tight or it may burst.

Indices of Refraction. The sine of the angle of incidence, the sine of the angle of refraction being taken for unity. (See *Lens.*)

Indigo. $C_{16}H_{10}N_2O_2$. Dark-blue powder, insoluble in water, alcohol and ether; soluble in strong sulphuric acid and creosote. Used as a pigment in photographic coloring processes.

Indophenol. Syn., Napthalene-blue. Suggested, instead of azaline, in combination with malachite-green, as a color sensitizer in orthochromatic work.

Inflection. An optical term used to denote the bending of the rays of light when they reach the edge of an opaque body. *Diffraction* is perhaps a better term than inflection.

Ink for Writing on Photographs. A good white ink suitable for this purpose can be made by mixing barium sulphate (precip.) with thin gum-arabic solution. For an ink with which to write titles or descriptive matter upon the dark portion of a photograph use the following solution:

Potassium Iodide	20 parts.
Distilled Water	60 "
Iodine	2 "
Gum-Arabic	2 "

Ink Process. Used for making prints in ink from photographic negatives. In the first place blue prints are made, the iron salt in which is then changed into ink by treatment with gallic acid. (See INDEX.)

Inorganic. All substances which are neither animal nor vegetable are termed inorganic.

Insensitiveness. When for any reason a sensitive surface refuses to record the impression after due exposure to light, it is said to be insensitive. This defect is sometimes found in old unexposed films.

Instantaneous Lens. Any lens which will give a sharply defined image when used with a large aperture, may be called an instantaneous lens, and is suitable for instantaneous work. Most rapid rectilinears, portraits, and wide-angle lenses are sufficiently rapid for this purpose.

Instantaneous Photography. Since the sensitive dry plates have come into general use the securing of negatives of moving objects has been placed within the grasp of the average worker. Instantaneous photography comprises the photography of motion in every form and phase. For such work a quick plate, rapid lens and shutter, skill and experience are essential. A good light is also indispensable. Among the principal achievements of instantaneous photography during the past few years, the photographing of flying bullets, cyclones on the move, lightning, and animal locomotion stand conspicuously.

Instantaneous Positive Paper. This is made in several ways, from which the following formulæ are selected:

No. 1. The paper is first brushed over with a solution made of

Bromide of Potassium	4 grains.
Iodide of Potassium	1 grain.
Gallic Acid	½ "
Water	1 ounce.

and dried. It is then sensitized with

Nitrate of Silver	20 grains.
Acetic Acid, No. 8	1 drachm.
Water	1 ounce.

Expose wet to the solar camera, or dry under the pressure frame, and develop with a saturated solution of gallic acid (filtered), adding occasionally a drop or two of the silver solution until the desired strength is obtained. Fix, tone, and wash in the usual way. The *whole* operation must be conducted by the feeble light of a candle or lamp, as the least daylight will darken the whole sheet.

No. 2. Make a saturated solution of chloride of mercury. To one ounce of this solution add one pint of water. Float the paper on this solution and when dry sensitize with

Nitrate of Silver	1½ ounce.
Water	1 "

When dry expose in the pressure frame. The paper must not come in contact with the light until the moment of exposure. The

print is at first feeble, but is strengthened by means of a solution of

Protosulphate of Iron . . .	15 grains.
Glacial Acetic Acid	1 drachm.
Water	1 ounce.

It is necessary to watch carefully so as to stop the development in time. Wash immediately in several waters and fix in hyposulphite of soda.

No. 3. First the paper is salted with solution of

Common Salt from . . .	6 to 10 grains.
Lemon-juice from . . .	1 to 3 drops.
Filtered Rain-water . . .	1 ounce.

Use a fresh lemon, and cut it with an ivory knife, or make a hole in it with a pointed stick. Filter. The paper should remain in this bath at least two minutes. Dry. Excite with

Nitrate of Silver from . .	20 to 30 grains.
Lemon-juice	10 minims.
Water	1 ounce.

Filter, and float the paper for two or three minutes, and dry. Expose in the pressure frame, or behind the solar camera until a faint impression is visible, then intensify with fresh solution (well dissolved and filtered) of

Gallic Acid	4 grains.
Water	1 ounce.

to the required strength. Wash immediately and fix in

Hyposulphite of Soda	1 ounce.
Water	20 ounces.

Let it remain in the bath for fifteen or twenty minutes; wash well and hang up to dry. All photographic prints upon paper should be washed in running water from six to sixteen hours. In no case should instantaneous papers be exposed to daylight previous to fixation.

Instantaneous Shutters. For the general run of photographic work the lens cap is all that is needful for the regulation of the exposure of the plate. With very rapid plates, and when photography of moving objects is in question, an exposure shutter which will permit of an exposure of any desired fractional period of time is necessary. Such a shutter is called an instantaneous shutter, and may be obtained commercially in many different forms, of which the old and well-known drop shutter is a good example. The most recent developments in the direction of exposure shutters can be seen on reference to the catalogue of any dealer in photographic supplies.

Intaglio. An engraving sunken or hollowed out so that an impression therefrom would give the appearance of a bas-relief. (See *Photographic Processes* and *Lithography.*)

Intaglio Processes. Processes of engraving by which the image obtained is sunken below the surface of the plate instead of being in relief, are called intaglio processes. (See *Photogravure.*)

Intense. In photography that degree of darkness in the shadows of a picture (negative) impervious to light. Sometimes confounded with density, which means opacity from the closeness of the atoms in the sensitized collodion film. A picture may be intense without density, but cannot be dense without intensity. The collodion film, however, may be dense without intensity before exposure. (See *Density.*)

Intensification. The name given to the process by which the density of a negative or positive image is increased or made more intense. Wet collodion plates may be intensified simply by re-development, by which the deposit of silver upon the plate is increased. Dry plates may be intensified either by the substitution method or by increasing the deposit of silver, as with collodion plates. The favorite method is to bleach the image with mercuric chloride and afterward immerse it in ferrous oxalate. In this method the two chief precautions necessary are to eliminate the hypo that remains after washing before treating the negative with mercuric chloride, and to wash away the excess of mercuric chloride before using the ferrous oxalate. The first is done by a few minutes' soaking in an acidified alum solution, and by applying the ferrous oxalate in a dull light, such as is used for manipulating carbon tissue and printing-out papers in. If a little mercuric chloride is left when the ferrous oxalate is added, its only effect will be to retard the blackening of the image.

The intensification method here indicated may be briefly stated as follows: The negative to be intensified is first thoroughly washed, and then bleached with mercuric chloride in the ordinary way. It is then thoroughly washed again and flowed over

with a ferrous oxalate solution prepared as follows: Pour one ounce of a saturated solution of ferrous sulphate into five or six ounces of a saturated solution of potassium oxalate acidified with oxalic acid, and then add three or four ounces of water.

The result of this method of intensification is that each atom of silver in the original image has now come into association with an atom of mercury, and the intensified image is amenable to further intensification, as was the original one.

A Copper-Silver Intensification Method. Plunge the negative into a solution made as follows:

Sulphate of Copper	6 parts.
Bromide of Potassium	1 part.
Water	100 parts.

In this solution the image is bleached with more or less rapidity. The intensity obtainable may be graded by prolonging the time of immersion in this bath. When bleached the negative should be placed in a bath of nitrate of silver solution 1 to 5, when it will acquire its natural color, with added strength.

Gallic Acid and Silver Intensifier. This acts considerably slower than the above, and for this reason is to be preferred.

Solution A.	
Gallic Acid	1 part.
Alcohol	10 parts.
Solution B.	
Silver Nitrate	1 part.
Glacial Acetic Acid	½ "
Distilled Water	16 parts.

The plate must be absolutely freed from hypo as described above, and for use mix one part of solution A with four parts of distilled water and add a few drops of B. This may be used in daylight and the solutions will keep clear for some time.

In consequence of the alcohol the solution flows badly on some plates and therefore it is advisable to soak the plates first in a dilute alcohol 1:4, or else to omit the alcohol altogether from the above formula and use an aqueous saturated solution of gallic acid and add to it an equal quantity of

Silver Nitrate	1 part.
Glacial Acetic Acid	1 "
Distilled Water	50 parts.

Mercuric Chloride and Ammonia Method. In this method, which is commonly followed, the negative, after a thorough washing, is bleached in a saturated aqueous solution of mercuric chloride strongly acidified with hydrochloric acid, and the image is blackened with a solution of 1 drachm of ammonia in 1 ounce of water.

Potassio-Cyanide of Silver Intensifier. The negative is bleached in the ordinary way, washed well, and then blackened in the following solution:

Potassium Cyanide	20 grains.
Silver Nitrate	20 "
Distilled Water	2 ounces.

There should always be a white flocculent precipitate in this solution, and if there is not, more silver nitrate should be added till on shaking a permanent precipitate is formed. The negative quickly turns dark brownish-black in this solution, and it should not be allowed to remain too long or the half-tones are attacked.

Intensification with Hydroquinone. The negative is immersed in a solution of

Old Hydroquinone Bath	55 parts.
Citric Acid 1:10	20 "
Red Potassium Prussiate 1:10	10 "
Water	50 "

Mix in the order given.

In from two to three minutes the negative darkens, and when the desired intensity is reached, wash the negative in running water for ten or fifteen minutes.

If your negatives are stained yellow, if they are harsh and not transparent, treat them in this bath and the yellowness disappears, the contrasts are softened down, and the whole picture becomes very fine.

Cassebaum's Intensifier. Negatives can be evenly and vigorously intensified in the following way: First steep the plate in a faintly acid solution, then soak it in the following bath:

Nitric Acid	1 part.
Water	960 parts.
Chrome Alum	48 "

Rinse the plate well, then treat it in the following way. Prepare

A.	
Gallic Acid	120 parts.
Alcohol	480 "
B.	
Nitrate of Silver	30 parts.
Water	480 "

Mix thirty parts of each of the above solutions, then add thereto 480 parts of water;

cover the plate with the solution and leave it therein until the required density is obtained. Then wash.

Whatever method of intensification is employed it is very important that the negative should be freed from hypo soda and thoroughly washed. Upon this depends the success of the operation and the permanency of the negative. To free the negative of hypo soda various methods are suggested. The best plan is a thorough and careful washing. Another method is to immerse the negative in

Water	2½ ounces.
Hydrogen Peroxide . . .	½ drachm.

for ten minutes and afterward wash it to free it from the hydrogen peroxide.

As to the best time to intensify a negative opinion is divided. Negatives intensified while still wet or moist seem to attain greater density with less gradation than those intensified after they have been allowed to dry.

Intensifier. The solution which brings a weak negative up to proper vigor or intensity.

Intensifying. The art of increasing the intensity of a negative after development and fixing.

Intensity. That state of the finished negative which prevents the transmission of light through the shadows; the degree of opacity of the image, and the extent to which it obstructs transmitted light.

Interference of Light. Designating the phenomenon that two rays of light falling on the same point when meeting either increase or annihilate their effect.

Interior. A term in photography applied to indoor work. Interior photography has become one of the most important branches of the art, and requires the utmost skill and knowledge for its perfect accomplishment. For the successful photographing of interiors of buildings a camera equipped with swing back, rising front, and square bellows is necessary; a good wide-angle lens and a moderately rapid plate, preferably non-halation if windows facing the sky are to be included in the picture. The question of exposure can only be decided by the appearance of the image upon the ground-glass, the best results following generous exposure. Development should be given careful attention and should proceed slowly, a developer which will give abundant detail being preferable, such as metol. For large prints of interior views a matt-surface paper, such as bromide or plain salted paper, gives the best results.

Inulin. A peculiar starch-like substance. It may be obtained by boiling elecampane in four times its weight of water, and allowing the decoction to repose for a short time. It is distinguished from starch by the precipitate formed in the cold decoction by an infusion of gall nuts, not disappearing until the liquid is heated to above 212° F. Inulin is soluble in boiling water, but separates as the liquid cools. Used in photography as a sensitive film for glass or paper.

Invisible Image. After exposure of the photographic sensitive film to the action of light in the camera no change in its state can be observed, and yet an image of the object in the focus of the camera is impressed; the image in this stage of the process is termed invisible or latent. (See *Latent Image*.)

Iodate. A compound formed of iodic acid and a base in definite proportions. The iodates resemble the chlorates of corresponding bases. They may be easily recognized by the development of free iodine when treated with sulphurous, phosphorous, and hydrochloric acids and other deoxidizing agents, and by their solutions being converted into iodides when treated with sulphuretted hydrogen. They are all of sparing solubility, and many are quite insoluble in water. All the insoluble iodates may be obtained from the iodate of potassa, by decomposing it in solution by a solution of a soluble salt of a base. Iodate of silver sometimes forms in the collodion film, and retards its sensitiveness. This may be prevented by adding to dark collodion a few drops of the oil of cloves, or cinnamon, etc. The iodates have a retarding effect in collodion and are of little utility. (See *Hydriodate*.)

Iodic Acid. An acid compound of iodine and oxygen.

Iodide. A union of iodine with a base. Nearly all the iodides are employed in photography as sensitizers, the proportions being from 5 to 8 grains of iodide to 1 ounce of solution. (See also *Hydriodate*.)

Iodide of Aluminium. Subject iodide of lead and sesquisulphate of alumina to gentle ebullition for some time in a large quantity

of water; one part of iodide of lead will require about two parts of commercial sesquisulphate of alumina. The liquor then filtered from the residual matter, and sulphuretted hydrogen is allowed to pass through for a few seconds; it is again filtered and evaporated to dryness; the iodide of aluminium may then be dissolved out with alcohol, or, after treating with sulphuretted hydrogen, iodide of barium may be carefully added as long as any precipitate is formed; this, separated from the sulphate of baryta and evaporated to dryness, is sufficiently pure for ordinary purposes.

Iodide of Ammonium. Ammonium iodide. NH_4I. White powder, easily decomposed by air (becoming yellow), requiring tight bottling; soluble in water and alcohol. Used in collodions.

Iodide of Cadmium. CdI_2. Long, white, six-sided tablets, very soluble in water and alcohol; turns yellow in the light. Used like iodide of ammonium.

Iodide of Calcium. CaI_2. Colorless deliquescent needles, very soluble in water and alcohol. Used to iodize negative collodion.

Iodide of Lithium. LiI. White powder, very soluble in water, alcohol, and ether; becomes brown and melts in the air. Is sometimes used for iodizing collodion.

Iodide of Mercury. HgI_2. Formed by mixing a solution of iodide of potassium with free surplus of this salt, with a solution of a salt of the peroxide of mercury (red precipitate), in which the forming red iodide of mercury is re-dissolved. Used to strengthen negatives.

Iodide of Platinum. (Periodide.) Formed by the action of iodide of potassium on a weak solution of the bichloride of platinum. (See *Platinotype*.)

Iodide of Potassium. (KI.) A salt crystallizing in cubes and prisms, very deliquescent in damp air; very soluble in water, far less so in alcohol; reacts to alkali. Used as iodizer in collodion, also mixed with gelatine emulsion and oxalate and iron developer. (Retarder.)

Iodide of Silver. AgI. Yellow precipitate, formed by adding a solution of silver salt (nitrate of silver) to a solution of iodide of potassium or of cadmium. Is insoluble in water, alcohol, and ammonia, soluble in hyposulphite of soda, iodide of potassium, and cyanide of potassium. With free nitrate of silver it is very light-sensitive. Used in negative processes.

Iodide of Sodium. NaI. White powder, very soluble in water and alcohol; decomposes in the air. Used to iodize collodion.

Iodide of Starch. A compound of a deep-blue color formed by the union of iodine and starch. This is a valuable substance for detecting the presence of silver; by adding iodide of starch to solution of any substance containing silver, iodide of silver will be thrown down.

Iodide of Zinc. ZnI. Easily decomposed, deliquescent crystals, very soluble in water. Used to iodize collodion. It does not keep long.

Iodine. Gray-black tablets of metallic lustre, evaporating even at common temperatures. Little soluble in water, quite soluble in alcohol, ether, and solution of iodide of potassium. Solution of iodine in gelatine and collodion emulsions prevents fog, but decreases sensitiveness.

Solutions containing *iodates* yield, with nitrate of silver, a white precipitate soluble in ammonia; the *iodides* under the same circumstances give a pale-yellowish precipitate with nitrate of silver, scarcely soluble in ammonia, a bright-yellow one with an acetate of lead, and a scarlet one with the bichloride of mercury. The iodates deflagrate when thrown on burning coals, but the iodides do not. The iodates may also be tested as iodides, by first heating them to redness, by which they lose their oxygen, and are converted into iodides.—*Cooley.*

Both in the waxed paper and the collodion process the solutions often contain a small quantity of free iodine. This iodine, in contact with the silver bath, produces a mixed iodide and iodate of silver, and liberates nitric acid. It thus retards the sensitiveness of the film in proportion to the quantity of iodine present. Collodion of a full yellow color is less sensitive than the same rendered colorless; and when enough iodine has been liberated to give a red or brown tint, double the exposure will be probably required. If brown collodion be much used the nitrate bath may become sufficiently contaminated with free nitric acid to interfere with the sensitiveness of the film. A little free iodine is, however, often useful in collodion for positives to diminish the intensity and to keep the shadows clear

during the development. In cases of fogging of the negative collodion, a little free iodine is also advantageously used. Iodine is also advantageously used in the silver bath.—*H. H. Snelling.*

Iodine Tincture. A concentrated solution of iodine in strong alcohol.

Iodized. The collodion or other photographic substance employed for the reception of the image is termed iodized when iodine is added to it to render it sensitive.

Iodized Albumen. Albumen containing an iodide. Iodized albumen is used both for taking negatives on glass and for printing positives on paper. The negative process on albumen is due to Mr. J. A. Whipple, of Boston. The usual method of iodizing albumen is as follows: Take the whites of three eggs, which will give about 18 drachms of albumen, add six drops glacial acetic acid and stir the whole together with a glass rod for two minutes, then leave it to rest for an hour. Now slightly plug the neck of a clean glass funnel with a piece of sponge, and pass through it a few drops of distilled water to moisten it; then place on the sponge one scruple of iodide of ammonium and on the top of it pour the semi-coagulated albumen, and two drachms, by measure, of molasses. This passes readily through, dissolving in its passage the iodide of ammonium. The result should be a perfectly limpid solution; if such is not the case press the sponge more tightly into the neck of the funnel and filter till it is so. (See *Albumen Process*, etc.)

Iodized Collodion. A solution of iodide and bromide salts in plain collodion. (See *Collodion.*)

Iodized Paper. Paper prepared with a solution of a salt of iodine for printing by development. Besides the formulas given under *Instantaneous Positive Paper* (which see), the following may be used: Spread the paper with a solution of the double iodide of silver and potassium, let it dry gently but completely; then immerse it in pure water, iodized side downward, for from three to five minutes, according to temperature, to get rid of the whole of the iodide of potassium, and hang it up to dry. The solution of the double iodide cannot be diluted with water beyond a certain extent, as, if excess of water be added to it or used to dissolve its crystals, decomposition ensues. But one sheet should be washed at the same time in the same dish, and care must be taken to exclude air-bubbles. This paper is sensitized with the gallo-nitrate of silver either by brushing or floating. This process is now superseded by the gelatine emulsion paper printing process.

Iodized Waxed Paper. This is in reality "bromo-iodized waxed paper," and is used for negatives. Make it by dissolving in

Water	16 ounces.
Iodide of Potassium	200 grains.
Bromide of Potassium	50 "
Sugar of Milk	200 "

and add tincture of iodine till the solution is of a brown-sherry tint, then a fluidounce of strong gum-water. In this soak the paper for two hours and dry. When used sensitize in a bath of aceto-nitrate of silver 30 grains to the ounce.

Iodizing. A term applied to the process of coating the daguerrotype plate with the vapor of iodine and also to the impregnation of photographic films with salts of iodine.

Iodo-Bromide Collodion Emulsion. An emulsion which contains both iodide and bromide salt. It is less sensitive than the bromide collodion emulsion, but gives finer and softer negatives.

Iodo-eosin, B. A derivative of fluoresceïn, used as a color sensitizer in orthochromatic work.

Iodo-Nitrate of Silver. When a photographic layer on paper or glass is to be very sensitive it must be arranged so that the light first passes through a stratum of nitrate of silver dissolved in water before reaching the iodide of silver in the collodion or paper. There is a determinate compound of iodide of silver with nitrate of silver, which is obtained by dissolving dry iodide in a saturated solution of nitrate of silver, adding the former in small portions to the boiling solution until the latter is saturated. On the addition of water the solution deposits iodide of silver. When it is allowed to cool a salt separates in acicular crystals. Its composition is represented by $AgO, NO_5 + Ag_r$. It rapidly becomes intensely black when exposed to daylight—far more than do its two constituents separately. It is not decomposed by absolute alcohol, and that fluid does not dissolve it even when boiling. Every drop of water added to it immediately decomposes a portion of the crystals, which then become coated with a yellow crust of iodide of silver. If a few pure fresh crys-

tals be thrown into a beaker with distilled water they become converted into iodide of silver whilst falling to the bottom, but retain their form. The only solvent for this compound appears to be a concentrated solution of nitrate of silver. The fluid poured away from the double salt which first crystallizes in needles, when allowed to stand for some time deposits very regular distinctly-formed crystals of the same compound; these appear to be a combination of the octohedron with the hexahedron. This compound is always contained in the silver baths of photographers after they have been used several times. Hence all these baths become turbid on the addition of water, from the separation of iodide of silver. A solution of nitrate of silver containing iodide of silver—that is to say, an old bath—is, however, universally preferred by photographers to a freshly prepared one; the latter may be artificially combined with a little iodide of silver. Schnauss determined the solubility of nitrate of silver in water of 52° F., finding that 100 parts of fused nitrate of silver required 78.32 parts of water.

Iridescent Photographs. These have been produced in France by M. de Geymet. An image is obtained in bichromated gelatine on a glass plate and developed with powder of various bronzes. The iridescent appearance is produced by varnishing the picture with collodion, and backing it with black varnish.

Iridescent Stain. Unexposed dry plates which are old sometimes show an iridescent veil or fog upon development. This may generally be removed by rubbing the plate, after fixing, with the tip of the finger or with weak alcohol.

Iridium. A metal found as heavy, tin-like scales on treating platinum ore with aqua regia, and closely resembling platinum in appearance. The iridious salts are generally of a dark-olive green; the iridic are brownish-red. The tetra-chloride of iridium is used in the preparation of chloride of iridium printing-out paper, and in toning prints.

Iris Diaphragm. A diaphragm, or series of diaphragms, inserted between the two combinations of doublet lenses, and consisting of a number of thin plates of metal so arranged that the aperture of the lens may be increased or diminished by turning the ring to which it is attached backward or forward, causing the tongues of the plates to contract or enlarge the opening as desired. The iris diaphragm is more convenient than the Waterhouse form, and its use obviates the chance of the stops being lost or misplaced.

Iron, Peracetate of. (See *Peracetate of Iron.*)

Iron, Perchloride of. (See *Perchloride of Iron.*)

Iron, Protonitrate of. (See *Protonitrate of Iron.*)

Iron, Protosulphate of. (See *Protosulphate of Iron.*)

Iron, Printing with Salts of. 1. A process of printing with an iron salt, called *Kallitypy.* The paper is coated with a solution of ferric oxalate or other iron salts, exposed under a negative, as usual, but not printed as deeply as in platinum printing; the print is then developed with an organic salt combined with ammonia and silver nitrate, subjected to a short chemical washing, and then rinsed in water, a permanent print resulting. This process is patented, but prepared paper is obtainable commercially, with which working instructions are given. (See also *Blue Prints*, *Cyanotype*, and *Platinotype*.)

2. *Iron Printing.* The following process of photographic printing with the salts of iron is due to Mr. Hannaford. Float the paper on the following solution, and hang by one corner to dry in the usual manner:

Add:	Albumen	1 part.
	Water	1 "
	Ammonio-citrate of Iron .	50 grains.

To each ounce of a saturated solution of Bichromate of Potash.

The time of exposure will be rather longer than for silver prints, but not materially so. The picture should appear of a brown-ochre color on a yellow-ochre ground, showing details and half-tones as fully as an ordinary silver print. Wash well to remove the iron from parts not acted on by light, and darken by saturated solution of gallic acid. This is the process in its simplest form. A variety of tones may be obtained by modifications. To obtain a *gold tone*, sensitize, expose, and wash as before, and then immerse the print for two or three minutes in chloride of gold, ½ grain; water, 1 ounce. Wash thoroughly and darken with gallic acid. By immersion in very weak solution of iodide of potassium a variety of pinkish tones may be obtained.

For Prussian-blue tints proceed as before, substituting ferrocyanide of potassium for the gold. On development with gallic acid the picture will appear of a blue-green, which is converted into a bright blue by weak solution of hydrochloric acid, a few drops to the ounce of water. Red prussiate of potash gives a good blue-black, which hydrochloric acid converts into a dull blue. A solution of borax poured over a Prussian-blue print very materially deepens the color. Gum-arabic mixed with the sensitizing solution tends to give a ferrocyanide picture a decidedly green tint, but when simply developed with gallic acid the resulting positive is of a dark-bistre tone. Gum-arabic, however, is by no means a good size to employ, as the picture is very apt to wash off from some portions. Albumen, as recommended, is the best for the purpose in every respect. The greatest difficulty to overcome is the slight—very slight—discoloration of the whites to about the same extent as in developed silver prints. To remove this immerse the picture in a weak solution of carbonate of soda, ammonia, or acetic acid. The alkali produces a not over-agreeable tone, while the acid does not materially change the tint.

Irradiation. A term sometimes used instead of *halation*, which see.

Isinglass. The purest kind of gelatine, made from fish-bladder (sturgeon). Soluble in boiling water and weak acids. Used in mechanical printing processes.

Isochromatic Photography. (See *Orthochromatic Photography*, and the *Appendix*.)

Isomeric Bodies. Bodies of like composition, yet differing in appearance and properties.

Ivory. The tusks and teeth of the elephant and walrus. Used in photography as a printing surface. Chloride emulsion pictures on ivory possess a wonderful delicacy of detail and tones. Carbon prints can also be obtained on ivory by the transfer process.

Ivory, Imitation. This substance is the invention of Mr. Mayall, of London, and is made by mixing the white of eggs and powdered sulphate of baryta mechanically, rolling it out into slabs, and, when hard, polishing. Positive photographs are printed upon this substance from negatives in the usual way, taking care not to soak it too long in the solutions, or in washing.

Ivory-Black. Is obtained by calcining ivory in closed crucibles, and is sometimes used in the preparation of black varnishes.

Ivorytype. This is a peculiarly colored photograph, the invention of Mr. F. A. Wenderoth, of Philadelphia. The operation is performed by rendering the photographic positive on paper transparent, and coloring in oil or water-colors upon the face of the picture; attaching it to a plate of glass and backing it up with white Bristol board. The following directions are given for producing the same: Take the negative as usual. Then take a piece of card the size of the largest portrait to be made; get it boldly stippled in China-ink by a clever artist; then copy it carefully as a negative. Varnish, and keep it as a background negative. Print the portrait, keeping the background white. Then print the background through the above negative. Color by broad washes only, as the taste may dictate, washing in the background likewise. Then place the picture upon a warm plate and brush in once with melted white wax; then finish by backing it up with a warm, yellow paper in close contact with the picture. The tint of the paper behind may be altered as taste may dictate. The whole will have the effect of a real and well-finished picture on ivory.

J.

Japanese Lacquer. (See *Lacquer*.)

Japanese Paper, Prints on. A method of obtaining prints on Japanese paper is thus given by Burton: Paper is salted by drawing it through a warm solution containing 1 ounce of gelatine and 100 grains of ammonium chloride in 20 ounces of water, adding 5 ounces of a 10 per cent. alcoholic solution of sandarac or any other white resin. When dry, the paper is floated on a bath made by mixing a 10 per cent. ammonio-nitrate bath with an equal volume of the same bath neutralized with nitric acid. Toning and fixing are done in the usual way, but only a weak bath can be used. To dry the prints, attach them by the edges to a light wooden frame.

Jena Glass. Many lenses are now made of a new kind of glass, made at Jena, Austria, under the direction of Abbe. The introduction of this glass affords opticians a

variety of more than 90 different sorts of glass instead of about a dozen, as available hitherto. It is claimed that many advantages accrue from the use of the Jena glass, such as greater covering power, and freedom from astigmatism and achromatic aberration in lenses.

Jet. An appliance fitted to the optical lantern, by means of which the gases used in illuminating are united by air pressure upon the lime to produce incandescence.

Javelle Water. A liquid composed of 1 part of good, dry chloride of lime and 6 parts rain-water, well shaken, and a solution of 2 parts purified soda in 3 parts rain-water. The mixture is allowed to settle, when the clear liquid is decanted, ready for use. Serves to remove the last traces of hypo soda. For this it is used very much diluted (3 : 200 water). Aqueous extract of chloride of lime alone is sometimes sold fraudulently under that name. It quickly decomposes.

Jew's Pitch. (See *Asphaltum* and *Bitumen.*)

Jones' Stereoscopic Glasses. This invention consists of optical glasses giving a stereoscopic effect to single pictures of any kind, viewed through them with both eyes; devised by Mr. T. Wharton Jones.

Joubert's Photographic Process in Enamel Colors. This invention, by Mr. F. Joubert, has for its object improvements in reproducing photographic and other pictures, engravings, prints, devices, and designs on the surfaces of glass, ceramic, and other substances requiring to be fired to fix the same thereon.

For this purpose it is necessary to proceed in the following way: A piece of glass, which may be crown or flattened glass, being selected as free from defects as possible, is first well cleaned and held horizontally while a certain liquid is poured on it. This liquid is composed of

Saturated Solution of Bichromate of Ammonia	5 parts.
Honey	3 "
Albumen	3 "
Distilled Water	20 to 30 "

well mixed together. The whole is carefully filtered before using. The preparation of the solution and the mixing up with other ingredients should be conducted in a room from which light is partially excluded, or under yellow light, the same as in photographic operating-rooms, so that the sensitiveness of the solution may not be diminished or destroyed. In order to obtain a perfect transfer of the image to be reproduced, the piece of glass coated with the solution, which has been properly dried by means of a gas stove (this will only occupy a few minutes), is placed, face downward, on the subject to be copied, in an ordinary pressure frame, such as is used for printing photographs. The subject must be a *positive picture* on glass, or else on paper rendered transparent by waxing or other mode, and an exposure to the light will, in a few seconds, according to the state of the weather, show, on removing the coated glass from the pressure frame, a faintly indicated picture in a negative condition. To bring it out, an enamel color, in a very finely divided powder, is gently rubbed over with a soft brush until the whole composition or subject appears in a perfect positive form. It is then fixed by alcohol, in which a small quantity of acid, either nitric or acetic, has been mixed, being poured over the whole surface and drained off at one corner. When the alcohol has completely evaporated, which will generally be the case in a very short time, the glass is quietly immersed horizontally in a large pan of clean water and left until the chromic solution has dissolved off and nothing remains besides the enamel color on the glass; it is thereupon allowed to dry by itself near a heated stove, and when dry is ready to be placed in the kiln for firing. Enamel of any color can be be used; and by careful registering, a variety of colors can be printed, one after the other, so as to obtain a perfect imitation of a picture; also, the borders of any description can be subsequently added without any liability to remove or even diminish the intensity of the color in the first firing.

Judicial Photography. The application of photography to legal purposes has received much attention during recent years. Photography can be used effectually in the detection of forgery or alterations in valuable documents; in criminal work for identification purposes; and also for the recording of the exact nature and appearance of anything in dispute.

Juniper Resin. (See *Sandarac.*)

K.

Kaleidoscope Photography. The negative of the object should be taken on a small piece of mica, as it has to be printed from both sides, as in the design formed in the kaleidoscope each segment differs from the one next to it, being reversed. Take a piece of thin black paper, and, having drawn a circle upon it, divide it into 8, 12, 16, or as many equal segments as required; then cut out one of these segments, and mount the talc negative with a little gum to the opening. The notches at each division are for the purpose of allowing the lines on the sensitized paper to be seen and registered. Then mark a piece of sensitized paper with the compasses in the same manner, but merely at the edges. Next take a piece of board, covered with flannel, and lay the sensitized paper on it, and place the disk holding the negative over it, putting a pin through the two centres. The lines on the sensitized paper are then brought to correspond with the notches in the disk, and a piece of glass being laid over the one half, the whole may be held together by two American clothes-clips, and the printing commenced. It may be easily examined during printing; and when sufficiently exposed, the disk must be turned round until the next segment but one corresponds with the negative, and so on until the four are done. The pin must then be taken out and the disk reversed, and the alternate spaces printed on. The result will be a pretty kaleidoscope picture, which may be varied considerably from the same negative by altering its position in the opening. A group of flowers, or a single flower, a bit of moulding, in fact, almost anything, will produce a beautiful design.

Kallitype. A patented process for obtaining permanent prints with iron salts. The paper, which can be obtained commercially, is coated with two iron salts—ferric oxalate and ferric nitrate, and also with silver oxalate and silver nitrate. By exposure to light the ferric oxalate is reduced to the ferrous state. The print is developed by floating upon a bath made up as follows :

Rochelle Salt	1 ounce.
Borax	½ "
Water	10 ounces.

To which add 10 drops of a 20-grain solution of bichromate of potash. This gives black tones, which can be changed to purple by diminishing to one-quarter of an ounce. The prints should be left in the developing bath twenty minutes, after which they are fixed by immersion in two baths of water to which are added 4 drachms of ammonia.

Kaolin. Syn., China or white clay. A fine silicate of alumina resulting naturally from the decomposition of feldspar of granite. Employed in photography for decolorizing silver solutions and cleaning glass. A small quantity of kaolin is shaken up with a silver bath discolored by the coloring matter of albumen paper, etc.; the solution will become clear as the kaolin settles.

Kinesigraph. An instrument invented in 1889, by the use of which it is possible to obtain images of objects in motion at the rate of from ten to twelve exposures per second. The exposures are registered on a sensitive band unrolling from a drum at one side of the instrument to a similar drum at the opposite side.

Kinetograph. An instrument devised by Edison, which combines a photographic camera and phonograph in such a way as to make it possible to reproduce at one and the same time the movements and gestures of a speaker and the words spoken. The photographic impressions are recorded on a continuous strip of sensitive film at the rate of 46 impressions per second. This instrument has only recently been modified and perfected, and may now be regarded as a practical success for its purpose.

King's Preservative Process. The plate is coated in the usual way, sensitized in the ordinary manner, and after removal from the nitrate bath the plate is immersed in a prepared plate-box filled with distilled water; an indefinite number of plates may thus be prepared, and when required for use, taken out and drained in the usual way as if fresh from the nitrate bath; expose as usual and the same time as a fresh plate. To develop the picture, first pour on a solution of nitrate of silver, 15 grains to 4 ounces, and develop in the usual manner. A gutta-percha plate-box can be easily made, or any common wooden one can be made water-tight by being coated with a solution of gutta-percha dissolved in benzole.

Kinocyanine. $C_{28}H_{11}C_{10}$. An agent formed during the preparation of Paris-blue (kyanol); recommended as a powerful reducer of metallic salts, and as an excellent developer for

gelatino-bromide plates. The formula is as follows:

Sulphite of Soda	50 parts.
Caustic Soda	1 part.
Carbonate of Soda	140 parts.
Kinocyanine	10 "
Water	1000 parts.

Development is effected as usual: 4 ounces of solution will develop from 5 to 8 plates 5x7. It keeps indefinitely, but should be frequently filtered. Negatives developed with kinocyanine are as soft as those developed with ferrous oxalate or hydroquinone, but more energetic than those developed with eikonogen.

Kinonaphthol. The name given to a developer consisting of a combination of eikonogen and hydroquinone with salts of potash and soda. This developer is said to be automatic; the plate being simply soaked in it, and the image appearing without further manipulation.

Kit. A thin frame inserted in the plate-holder to permit of the use of a smaller plate than the holder was originally constructed for. In the plate-holders used by photo-engravers the kit is used, in addition to the usual arrangement, to hold the half-tone screen near to the sensitive plate during exposure. In Europe the "kit" is known as a "carrier."

Kite Photography. In collodion days (1859) photographs were taken from balloons. During the past few years two ingenious photographers, Messrs. Wenz and Batut, each working separately, have devised a method of obtaining photographs by means of a small camera attached to a large kite. Reproductions of pictures thus obtained have been published in the French journals, and exhibit the usual characteristics of balloon photographs.

Knife in Retouching. In skilled hands the knife—a small, pointed, keen-edged blade—can be made of great service in retouching negatives. By the use of this instrument a pointed nose may be reduced, a double chin removed, and a lady's waist manipulated with pleasing effect in the negative. Draperies and accessories may also be treated in the same way.

Kodak. A special form of detective camera, brought into the market by the Eastman Photographic Material Company, in a variety of styles.

Kopp's Color Photography. In 1891, Dr. R. Kopp, of Munster, Switzerland, announced a natural-color process, claiming to have united the advantages of the systems devised by Ives and Lippmann. Dr. Liesegang pronounced Kopp's claims sustained except as regards the permanency of the print. Dr. Kopp died in 1892. An account of his process in detail was given in *Wilson's Photographic Magazine*, March 19, 1892.

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Labelling Bottles. Strong white labels may be attached to bottles with the following gum:

Gum Arabic	1 ounce.
Gum Tragacanth (pulv.)	1 "
Acetic Acid	40 minims.
Glycerine	1 ounce.
Water	2 ounces.

Dissolve the gums in the water, hot, then add acid and glycerine.

An indestructible and non-corrosive ink may be made as follows:

Oil of Lavender	1 ounce.
Powdered Copal	1 drachm.
Lamp-black	6 grains.
Indigo	2 "

Dissolve the copal in the oil with gentle heat, then add lamp-black and indigo.

When the label is attached to the bottle, coat it and the surrounding glass with good copal varnish.

A good way to label dark bottles is to print upon them with white enamel and a small brush, an abbreviation of the title desired, in letters half an inch high.

Laboratory. A place fitted up for the performance of chemical operations.

Lac. There are several kinds of lac—shellac being the only one used in photography for making varnishes. See *Shellac*.

Lac, White. Dissolve shellac in a lye of pearlash or caustic potash by boiling; filter, pass chlorine through it in excess, wash the precipitate, and digest. Forms an excellent pale varnish with alcohol.

Lac Varnish. To prepare, take pale shellac, 5 ounces; borax, 1 ounce; water, 1 pint; digest at nearly the boiling-point until dissolved; then strain. This is equal to the most costly spirit varnish for many purposes; it is an excellent vehicle for water colors as

well as for photographs. When dry it is waterproof.

Lacquer. A good transparent lacquer for brasswork is made by dissolving celluloid in acetate of amyl. This, when applied, takes several hours to dry, but then remains hard and durable. A rich golden lacquer is made of alcohol 8 ounces, powdered turmeric 1 ounce; macerate for a week, then carefully filter and add ¾ ounce light-colored shellac, ¼ ounce gamboge, and 3½ ounces gum sandarac. When the whole has been dissolved by heat 1½ ounce of common turpentine is added. Apply to the article in a warm room.

Lactate of Silver. $CH_3CHOHCOOHAg$. White needle-like crystals, very soluble in water and quickly blackened in the light.

Lactic Acid. $C_3H_6O_3$. A free acid contained in milk; colorless, of syrupy consistence, scentless, very acid, deliquescent; readily mixing with water and alcohol, less so with ether.

Lacturin. Lacturin and casein have both been recommended as media for preparing glass surfaces for the photographic processes. These compounds, which are of a very analogous character, are prepared from buttermilk by the action of acids; it is proposed that they should be used dissolved in ammonia. When this is done, the glass being uniformly coated by flooding the solution over it, it may be allowed to stand in a warm place, free from dust, to dry; this occupies some time, but if the process has been carefully attended to the resulting coating is very uniform and clear. Iodide of potassium or of ammonium may be mixed with the lacturin solution, before it is applied, the other parts of the process being precisely similar to others described in this work.

Lacy's Negative Process. The principal feature in this process was the method of strengthening or intensifying the negative. Now obsolete.

Lambertype. An enlarging process, named after its inventor, Sarony Lambert, consisting in developing a pigment-picture upon a washed collodion plate, covering it with transfer paper, and when dry, removing it from the glass. A medallion or cameo-border, which may bear the maker's name, is used.

Lamp-Black. Black soot, obtainable by holding an iron spoon in the flame of burning oil of turpentine. (See *Pine-Soot.*)

Lamp for Dry-Plate Work. A contrivance of this sort is necessary in order to protect the sensitive emulsion plate from being affected by the light. The chimney must be ruby-red, and the light of the lamp is not to be allowed access longer than is absolutely necessary. (See Fig. 126.)

FIG. 126.

Lamprotype. This style of positive glass picture was introduced by S. A. Holmes, of New York. Take the ambrotype in the ordinary way, giving it all the time it will bear; dry the plate perfectly, then apply a fine *dry* buff to the collodion-silvered surface; polish it bright and clean, setting the grain across the plate; this will take off the brown, sombre look of the plate and give an intense, soft and clear texture to the picture not otherwise obtained.

Landscape. The scenery presented to the eye in the country; as also, in its more common acceptation, a picture representing such scenery. A landscape in the latter sense may, however, become allegorical and historical, in the meaning applied by artists to these terms.

Landscape Lens. The kind of lens required for landscape work is determined by the subject, whether inanimate (pure landscape) or animated (landscape with figures). For pure landscape work, without figures or architectural features, a single achromatic lens will give brilliant and crisp definition in the picture. For general landscapes, in which figures or buildings may be included, any good medium-angle doublet, symmetrical, or rectilinear lens will be found suitable. With regard to the angle of view which it is desirable to include in a landscape, from 45 to 60 degrees will give the most satisfactory results.

Landscape Photography. In order to obtain pleasing pictures of outdoor scenes with the camera, it is necessary to have, in addition to a knowledge of technique and the limitations of one's instruments, an understanding of the rules of art—of composition and chiaroscuro. Every scene which looks

pretty to the eye will not make a picture when translated by the camera. The photographer must know how to arrange, compose, and select his views so that the resulting picture will be effective and pleasing. This knowledge may be had by studying some good works on art, such as Burnet's *Art Essays*, Robinson's *Pictorial Effect in Photography*, *Wilson's Quarter Century in Photography*, etc., and applying their teaching in practice.

The choice of point of view, and of time of day which best expresses the spirit of the scene, the lighting of the subject, the relation of the height of the horizon to the foreground, the prominence to be given to this or that feature, are the chief points which require consideration in landscape work.

With many scenes the introduction of figures adds interest to the picture, but care is needed in the arrangement of the figures and their proper placing with relation to the apparent size of other objects in the picture.

The securing of the clouds on the same plate as the landscape is always desirable, but not always possible. The use of a cloud shutter will greatly facilitate this work. Clouds add so much effectiveness that their judicious use is advised wherever possible. A collection of cloud negatives for use with landscapes without natural skies will be found useful in this connection.

Lanneau's Cleaning Fluid. A fluid used for cleaning daguerrotype plates.

Lantern Slides. Glass transparencies intended for projection by means of a magic lantern. They may be drawings, paintings, or photo-positives. (See *Positives*, and *Transparencies*.)

Lantern Slides without a Camera. Thin, flawless crystal plates are coated with a varnish made as follows:

Gum Sandarac	2 parts.
Gum Mastic	2 "
Sulphuric Ether	100 "
Benzole	20 "

This dries rapidly and gives a matt surface suitable for working upon with chalk or pencil. When the drawing is completed the slide can be made transparent by flowing with

Gum Sandarac	3 parts.
Gum Mastic	3 "
Sulphuric Ether	100 "

The drawing is thus protected by two coats of varnish.

Laryngoscopic Photography. Dr. Musehold, of Berlin, has photographed the human larynx successfully, using the laryngoscopic mirror and glass, and immediately it is in sharp focus. The exposure is made by means of the flash-light.

Latent. Concealed; secret; not visible or apparent.

Latent Image. The invisible image produced by light, either transmitted, reflected, or by contact with or without pressure of two bodies. Professor Moser's researches on the *formation of the photographic image* has given rise to the following conclusions:

1. Light acts upon all bodies, and upon all in the same manner; the effects hitherto observed are only particular instances of this general law.

2. The action of light consists in modifying bodies in such a manner that after this action they absorb certain vapors which they could not otherwise; the process of M. Daguerre depends on this and offers a particular instance of this general action.

3. The vapors are condensed, more or less strongly, by the bodies thus modified, according to their elasticity and the intensity of the light.

4. Iodide of silver, as is known, becomes blackened under the influence of light.

5. If the action of the light be continued the iodide is transformed and becomes colored.

6. The different refrangible rays have one and the same action, and differ only in the time they require to produce a given effect.

7. The blue and violet rays and the obscure rays discovered by Ritter commence the action very speedily on the iodide of silver; the other rays require, to produce the same effect, as much more time as their refrangibility is less.

8. Yet the action (5) is more quickly commenced and effected by the red and yellow rays, the others requiring more time as they have a greater refrangibility.

9. All bodies radiate light, even in perfect darkness.

10. This light does not appear to belong to phosphorescence, for no difference can be discovered, whether the bodies be placed for a long time in the dark, or whether they be exposed to the light of day, or even to the direct rays of the sun.

11. The rays emanating from different bodies operate in the same manner as sensi-

ble light, and produce the effects indicated at 2 and 4.

12. These rays, insensible to the retina, have a greater refrangibility than those of the sun, whether direct or diffused.

13. Two bodies constantly imprint their images on each other, even when placed in perfect darkness (1, 9, and 11).

14. Yet for these images to be appreciable, it is necessary, in consequence of the divergence of the rays, that the bodies shall not be very distant.

15. To render the representation of a body visible some vapor should be used, such as the vapor of water, of mercury, iodine, chlorine, bromine, or chloride of iodine, etc.

16. As the rays which bodies spontaneously emit have a greater refrangibility than those which were previously known, they generally commence the action on other bodies with the greatest intensity (7).

17. There exists latent light as well as latent heat.

18. When a liquid is vaporized, light, corresponding to a certain degree of oscillation, becomes latent, and is again set at liberty when the vapor condenses into liquid drops.

19. It is on this account that the condensation of vapor produces, to a certain extent, the same effects as light; thus is explained the action of vapor as noticed 2 and 15.

20. The condensation of vapor on the plates acts in the same manner as light, whether the excess of vapor simply adheres, as is the case with the vapor of water on most substances; whether it adheres permanently, as in the case of mercury; or, lastly, whether it chemically combines with the substance, as does the vapor of iodine with silver.

21. The latent light of the vapor of mercury is yellow; all the effects produced by the yellow rays may be obtained by the condensation of the vapor of mercury.

22. The latent light of the vapor of iodine is blue or violet; the action of the blue or violet rays may in like manner, as in the former instance, be produced by the vapor of iodine.

23. The latent light of chlorine, bromine, chloride, and bromide of iodine appears to differ but little in refrangibility from that of iodine.

24. With regard to the color of latent light of the vapor of water it can only be said that it is neither green, yellow, orange, nor red.

25. Iodide of silver owes its sensibility, in contact with the visible rays, to the latent light of the vapor of iodine.

26. Iodide of silver is not more sensitive to the invisible rays than is silver itself. (See *Development of the Image.*)

Latent Light. Light insensible to the eye; concealed or possessed by bodies, but not visible. (See *Latent Image.*)

Latitude and Longitude. These can now be determined by means of photography. It is done, in ascertaining latitude, by photographing two stars at the north and at the south and calculating the latitude from the distance between their images on the plate. In ascertaining longitude the moon and a known star are first photographed, and the longitude is calculated from the distance separating them on the plate.

Lavender, Oil of. This is prepared by distillation from lavender flowers. A pale yellow liquid freely soluble in alcohol. Used in early photo-mechanical processes as a solvent for bitumen, as a solvent for pyroxylin in making photo-enamels, and as an addition to some shellac varnishes.

Lavigne's Toning Process. M. Lavigne recommends the following formula with the ordinary fixing bath of hyposulphite of soda:

Chloride of Gold and Potassium .	15 grains.
Chloride of Sodium	150 "
Water	7 pints.

Law of Combinations. (See *Equivalents.*)

Lawrence's Transparent Printing Process. Coat the plate with negative collodion, excite in the negative bath, and then plunge it up and down in a bath of distilled water until all the oily streaks disappear. Next pour over the film a large quantity of water to wash away the free nitrate of silver, and then treat the plate with gelatine in the same manner as for Dr. Norris' dry plates. Place this dry plate with the negative to be copied in a printing-frame, and expose it for *about* two minutes to the light of an Argand gas-burner, the rays of light being concentrated and rendered parallel by a plano-convex lens. The plate is then returned to the bath of distilled water for three or four minutes to soften the gelatine, when the picture may be developed with the ordinary iron developer, and intensified with bichloride of mercury.

Lead. A white metal with characteristic bluish-white tint, malleable, and quite soft.

Lead acetate is used in photography for toning and fixing baths, and has been proposed as a hypo-eliminator. Lead chromate is used to color fabrics for dark-room windows. Lead nitrate is used in certain processes of intensification, and also in combined toning and fixing baths, as in the subjoined formula:

Distilled Water	20 ounces.
Hypo Soda	4 "
Sulpho-cyanide of Ammonium	½ ounce.
Acetate of Lead	60 grains.
Nitrate of Lead	60 "
Alum	60 "
Citric Acid	60 "
Chloride of Gold	4 "

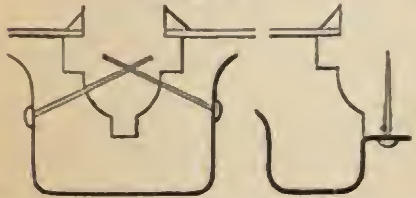
Mix in the order given, and let each dissolve before adding the next.

Lead, Printing with. A process of printing with acetate of lead, called *plumbotype*, was suggested by M. Roussin in 1892. It was, however, valueless, the image obtained being merely iodide of starch.

Lead Intensifier. A solution of nitrate of lead and ferricyanide of potassium in water. Powerful intensifier for wet collodion plates, also for gelatine negatives, if acetic acid is added.

Leaky Skylight. Mr. E. W. Mealy proposes the plan which follows for the prevention of the leaking of a skylight. He says: "Every photographer knows that a skylight

FIG. 127.



seldom if ever leaks except along the ribs of the sash, unless there is a broken pane. My plan is this, and it can be applied to either wooden or iron sash, by drilling holes through the latter; if the sash is wood, brads may be used. I have made gutters, as described below, to run the full length of each rib, the same shape as the rib but a little larger, so as not to allow it to touch. (See Fig. 127.) I use only half of the gutter, and it is tacked on in such a way as to catch the drip. It should be put on so that the edge barely touches the glass on either side of the rib, and flare out a little in order to receive the drip. These gutters should all connect at the bottom with one gutter with a pipe that carries the water outside of the building.

Leather Collodion. Enamel collodion. Collodion containing castor oil, which renders the film more pliable. Used in stripping films and enamelling prints.

Leather Process. This process simply consists of transferring the ambrotype picture to black leather and is performed as follows: Take 1 ounce 95° alcohol, add 8 drops of nitric acid, and shake it well; then take an ambrotype, rather lighter than you wish it to be when finished; dry over your spirit lamp or in an oven; lay it on your table, film up; take a matt the size you require and place it over the picture, then with a sharp-pointed stick run around the inside of the matt, which takes the collodion off clean if the point is moistened. Then take another piece of wedge-shaped wood, moistened, and rub the remainder of the collodion off the margin of the glass. Now take a good, smooth piece of enamelled leather and clean it with wheat flour and canton flannel, dust off thoroughly and pour on your alcoholic preparation as you would collodion; then place the lower edge of your leather on the plate and hold it firm with one hand, and with the other carefully lay the leather on the picture, commencing at the lower edge, so as to exclude the air and drive off superfluous liquid; lay a piece of glass on the leather and place a weight upon it and let it remain for about five minutes, when, upon removal, the picture will be found adhering firmly to the leather. If the picture is to be colored, it must be done before the transfer is made.

Le Gray's Toning Process. Take of

Distilled Water	1000 parts.
Chloride of Lime	1 part.
Chloride of Gold	1 "
Chloride of Sodium	1 "

The print may remain half an hour in this bath without injury, and as the toning takes place slowly, it becomes easy to stop it when the desired tint is obtained.

Le Gray's Wax-Paper Process. Very fine paper, it must be remembered, is *the* desideratum in all waxed-paper negative processes. It should be selected very clean, and free from particles of metal, iron marks or black specks, and of a creamy color. It is well to mark each sheet, as selected, on one side with the operator's initials, in order

that when the paper has been prepared, and whilst it is submitted to the action of the various baths, the proper size may be known. The sheets should be cut of a size somewhat larger than the required dimensions of the picture to be obtained.

Waxing the Paper. Procure a sheet of plate glass, or what is better, of smooth zinc of a sufficient size for the paper which it is intended to use. Fix it by means of a suitable stand over a small spirit lamp, or place it on a hot-water bath. Having on hand some of the purest white wax that can be obtained, rub the upper surface of the glass or metal plate well over therewith, until the heat has dissolved as much of the wax as the plate will hold without running over the sides; on this carefully deposit the paper, pressing it down evenly and keeping it there until the wax is thoroughly absorbed, and the paper can take no more, being saturated.

This part of the process may be facilitated by rubbing another piece of wax over the upper surface of the paper; the sheet is to be taken off the plate, and placed between a few folds of clean white blotting-paper, and ironed with a heated iron to remove all excess of wax. The iron ought not to be too hot; it is sufficiently so when a drop of water let fall on its face quickly evaporates; should the drop spin, however, or run off, we may be certain the iron is too hot, and must be somewhat cooled.

It is very necessary that the wax should be removed from the surface of the paper, and remain only in the body of it. If the paper appear equally transparent, and without any shining patches or spots when viewed with a side light, it is properly ironed. Should these appearances present themselves, the paper will require again ironing until they disappear.

Preparation of the Negative Paper. In a retort or earthenware vessel of suitable dimensions, put about 8 ounces of clean rice, with 6½ pints of water (*pure distilled*). Set it on the fire to boil gently for a minute or two, until the grains of rice become slightly broken; if suffered to continue longer, the liquor obtained will be thick with the excess of coarse starch, and paper steeped in it will be rendered black or speckly in the after-operations.

Strain this liquid through a piece of clean linen or muslin, and set it aside for use.

Iodizing the Paper. Make a bath according to the following formula:

Rice Water (by measure) . .	42 ounces.
Sugar of Milk	600 grains.
Iodide of Potassium . . .	520 "
Cyanide of Potassium . .	15 "
Fluoride of Potassium . .	8 "

When completely dissolved, filter through fine linen. In this solution the waxed papers are to be immersed. If not required for immediate use it should be preserved in a bottle, and will keep for a considerable time without decomposition. When papers are to be prepared, they may be immersed sheet upon sheet, taking care to drive away all air-bubbles that may be perceived under them; from one to two dozen sheets can be prepared at a time. Here they must remain for a period proportionate to the thickness of the paper made use of—from half to three-quarters of an hour will generally be found long enough; after this time the whole mass of sheets should be turned over, bottom upward, and the papers removed one by one, holding them to drain over the shallow bath, and then pinning them from a line stretched across the room to dry in the air. A small portion of white blotting-paper stuck to the bottom corner of the sheet facilitates the removal of superfluous moisture.

The following formula, on the authority of Mr. Fenton, is used by M. Pulch, of Paris, and appears to have been employed with much success. Papers prepared according to his directions, are much more sensitive than those by the above formula, but unfortunately they will not keep more than three days in summer, or a week in winter; neither will they bear long the action of gallic acid. His formula is the following:

Distilled Water (by measure) .	35 ounces.
Iodide of Potassium . . .	246 grains.
Bromide of Potassium . .	15 "
Cyanide of Potassium . .	15 "
Fluoride of Potassium . .	7½ "
White Honey	154 "
Sugar of Milk	231 "
The White of an Egg.	

The paper, so far, is nearly insensible to light,* and consequently may be prepared in the daytime, if kept from the direct action of the solar rays. Thus iodized, the papers may be kept in a portfolio or drawer ready for

Applying the Sensitive Solution. This must be made by candlelight, and kept in a stoppered glass bottle, covered with black or yellow

paper; it is prepared in the following proportions:

Distilled Water	. . . .	150 grains.
Crystallizable Acetic Acid	.	12 or 14 "
Crystallized Nitrate of Silver	.	6 "

The above is adapted for such papers as are intended to be used some considerable length of time after sensitizing—but if required for immediate use, or within two or three days, it is as well to diminish the quantity of acetic acid. Sufficient of this sensitive solution is poured into a flat, shallow bath or dish, to cover the bottom to the depth of about a quarter of an inch. The sheet of iodized paper is then to be carefully immersed, the side on which the picture is intended to be, downward, and then quickly turned over; see that no air-bubbles collect under the paper. After remaining for four or five minutes, remove it into another dish containing a sufficiency of distilled water, where it is to be left an equal space of time, and shaken about, to re-dissolve any excess of the aceto-nitrate. The sheet is then dried between white blotting-paper; if left to dry in the air, it is liable to become quite black in the gallic acid afterward to be used. If preserved from the action of light it will, when prepared by the first formula, keep good and fit for use a fortnight—if with a smaller quantity of acetic acid, it will not keep so long, but is more sensitive.

Exposure in the Camera. On the duration of the exposure very little can be said, so much depends upon the quality, diameter, and aperture of the lenses, the intensity of the light, and the temperature of the air. With a double combination of 3 inches diameter, for a portrait in the shade on a clear day, the time is from twenty seconds to one minute. For views with a single achromatic and a stop of about three-quarters of an inch in diameter, the exposure will vary from half a minute to twenty minutes, according to the brightness of the season and the surrounding temperature. After the exposure in the camera, and until developed as follows, very little of the picture will be visible. If by any circumstance it be rendered necessary, the remaining operations may be deferred without any material disadvantage for a couple of days.

Developing the Picture. Provide another shallow dish, into which pour to the depth of a quarter of an inch some of the following solution:

Distilled Water (by measure)	.	42 ounces.
Gallic Acid	. . . . .	60 grains.

In this completely immerse the proof obtained and yet almost invisible, observing again all the before-mentioned precautions against air-bubbles. Allow it to remain until the picture appears to be sufficiently developed, which may be in five minutes, or it may require perhaps several hours to bring it out, this being dependent on causes connected with temperature and the duration of exposure in the camera. If the weather be cold, it is advisable to warm the solution a few degrees, and should we desire still further to hasten the development of the image, the addition of from ten to twenty drops of the aceto-nitrate, or sensitizing solution, will effect this in a surprising degree; unless, however, the development be closely watched, the darks of the picture may be rendered too violent, as we can thus obtain very intense blacks. As soon as it appears to have acquired the desired tones, immediately remove the sheet into a dish containing clean water, and wash it well, changing the water two or three times, and gently brushing or rubbing the back of the picture to effect the removal of any adhering crystals. After being well washed, the proof is ready for

Fixing the Negative Image. For this purpose have ready a bottle containing the following solution:

Water (filtered)	. . . .	1 pint.
Hyposulphite of Soda	. . .	2 ounces.

Pour sufficient of this solution into a dish, then carefully immerse the paper, and let it remain at least ten minutes, agitating it from time to time. Only one proof should be immersed at a time. When removed from the bath, it is important to thoroughly wash away every trace of hyposulphite, for which purpose a *quantity* of water is necessary.

Thus treated, the picture is completely fixed and incapable of the further action of light; it only requires drying and finally submitting to the

Waxing of the Negative Proof, which is done by holding it before a gentle, clear fire, carefully keeping it from dust, until the wax regains the transparency which it has lost by the various baths and solutions to which it has been submitted; and,

until this be done, the pictures have a stained or soiled appearance, which will now vanish, leaving a splendid negative picture, from which an unlimited number of positives, having their lights and shades in their proper places, may be obtained by superposition.

Le Grice's Ambrotype Process. This process was first communicated to the French Photographic Society in July, 1857, by M. Le Grice. His pictures had the strongest lights well rendered, without presenting a metallic aspect. The pure whites preserved their modelling although properly contrasted with the deep shadows. The muscles of the face were well marked, a thing rare in paper portraits, and usually set right chiefly by the hand of the artist.

All simply iodized collodions free from bromides, fluorides, etc., and a bath unimpregnated with iodide of silver, give pictures which are simply black and white, having neither half-tint nor modelling. Hence the various additions to a normal collodion and bath. The combination found to succeed best is as follows: Mix in a flask *cautiously*, 78 grains of bromine and 7 drachms of absolute alcohol. Then pour this mixture into another flask containing 78 grains of hydrated lime (slaked lime); stir, and add from twenty to twenty-five drops of hydrochloric acid. After a few days the liquid which rests upon the undissolved lime loses its color and becomes clear as water. In this state it is used by adding ten, fifteen, or twenty drops of it to a collodion iodized by iodide of zinc. It is believed that a collodion containing this mixture is more sensitive than any other to the rays which proceed from red and yellow objects.

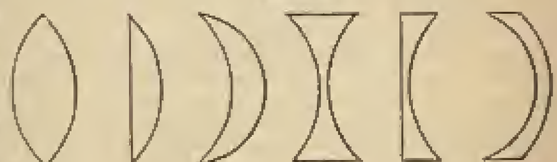
The image is rendered visible by sulphate of iron, with the addition of boric or acetic acid, and two or three per cent. of alcohol. The fixing is effected by hyposulphite of soda, or by cyanide of potassium.

To obtain negatives with this collodion, expose for a longer time, and after the image is fixed and washed, moisten it with a weak solution of nitrate of silver containing just a trace of iodide of silver. Then expose the plate to a very feeble, diffused light for a moment, and without washing plunge it into a solution of sulphate of iron, as above; wash again, etc. By this method we obtain negatives in which the half-tints are more marked than in those obtained by an ordinary negative collodion and developed by pyrogallic acid. A too long exposure to the diffused light sometimes causes the image to be transformed into a positive, as seen when examined by transmitted light. The same thing also occurs when the solution of nitrate of silver with which the plate is, in this additional process, moistened, contains too much iodide of silver.

Leimtype. A modification of the photo-etching and collotype processes invented by J. Husnik, of Prague. The printing surface is of chrome gelatine, instead of copper or zinc, and in this lies the peculiarity of the process. The blocks are exactly similar to ordinary zinc half-tone or line blocks, and are printed in the press in the same way; over 50,000 impressions can be taken from one plate without deterioration.

Lens. A transparent piece of glass with two convex surfaces, or one convex and one flat. The convex lenses (thicker in the middle than on the edges) cause the rays impinging upon them to converge; the concave lenses (thinner in the middle than at the edges) diverge them. The material from which lenses are made consists of crown

FIG. 128.

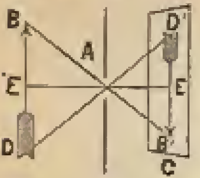


and flint glass (q. v.), and, lately, barium-silicate glass of comparatively high refrangibility ("Jena glass") has been used to great advantage. Fig. 128 illustrates the various forms of lenses as follows: The double convex, plano-convex, concavo-convex, double concave, plano-concave, or convergent meniscus, and divergent meniscus.

Light is propagated in a straight line. If a ray of direct sunlight passes through a small hole into a dark room and falls upon a screen, we observe a bright image of the shape of the hole. Increasing the distance, a round image of the sun takes the place of the image of the hole. More than this, if the hole is small enough, the image of the

small external objects will appear likewise. For example: Each point of the object *B D* radiates light in every direction—light of the same color as it appears to our eye. From the point *B*, no light can reach the screen *C*, except through the small aperture *A* at *B'*; but if the aperture is infinitely small, no other point of the object can send its rays to *B'*. The same is true for every other point, for *E* or *D*, for instance; these can only send rays to their respective points *D'* and *E'*, and so on with the rest, and an inverted image, with all the natural colors of the object, is produced on the screen. If we now enlarge the hole, different points of the object would reach the same place upon the screen; the image of these points would overlap each other, and the image of the object would be indistinct. If the aperture is sufficiently enlarged, the image disappears and the screen is illuminated homogeneously, taking only a tint of the most prominent colors of the objects. Therefore, the smaller the hole is, the sharper but fainter is the image.

Fig. 129.



Lens Tube. A hollow metal cylinder into which the lenses of which the objective is composed are fixed.

Lenticular Stereoscope. An instrument for producing a single solid picture by the union of two upon a flat surface by means of lenses.

Level Indicator. The simplest way of levelling the camera when photographing, is to use a string with a weight attached, similar to the familiar plumb-line.

Levelling Slab. A framework which, by screws and level, can be brought to a perfectly horizontal plane. Used as support for plates to be coated with emulsion, to insure even distribution.

Levelling Stand. An instrument for sustaining the daguerrotype plate, or collodionized plate, in a perfectly level position while gilding the former and while developing the latter.

Levigation. The process for reducing substances to *fine* powder, by making them into paste with water, and grinding the mass upon a hard smooth stone or slab, with a conical piece of stone having a flat, smooth under-surface, called a "*muller*." Levigation is resorted to in the preparation of paints on a small scale, and in the elutriation of powders.

Life-Size Photographs. Portraits of the natural size. These are now generally produced by enlarging small negatives by means of the solar and other cameras. (See *Solar Camera* and *Enlarging Photographs*.)

Light. Light is defined as the agent that produces vision; it is supposed to be either a material fluid of extreme subtilty emanating in particles from a luminous body, or that it is produced by the undulations of an independent medium set in motion by the luminous body.

In 1000 parts of white light we find:

Red rays	54 parts.
Orange-red	140 "
Orange	80 "
Yellow-orange	114 "
Yellow	54 "
Greenish-yellow	206 "
Yellowish-green	121 "
Green and greenish-blue	134 "
Blue	40 "
Blue-violet	20 "
Violet	5 "

From which we deduce that the brighter light rays exceed quantitatively the chemical active rays, a phenomenon leading to the opinion that the sensitive media at present used in photography utilize but a part of the light reflected from the object to be photographed.

Light, High. That portion of the picture possessing no shadow, and represented by the pure white of the paper, or the most brilliant touches of white paint.

Light, Standard. For the securing of a unit of illumination and for the determination and comparison of the sensitiveness of the materials used in photography, many efforts have been made toward a standard light. The requirements of a normal or standard light for use in this way may be said to be: (1) That it should be possible to obtain the light everywhere of absolutely equal intensity; (2) that the chemical intensity of the light should be constant; and (3) that it should emit all the spectrum rays which affect photographic sensitive material. So far, no light has been devised or found which will fulfil all these essentials. It has been found that magnesium, in optical brightness, gives a light more closely resembling sunlight than any other.

The various lights at one time or another proposed as a standard light are (1) the standard candle; (2) Violla's electric light unit; (3) the amyl acetate lamp; (4) the normal carbonic oxide light of Bunsen and Roscoe; (5) coal gas; (6) magnesium; and (7) phosphorescent substances.

The amyl acetate lamp would seem to most closely fulfil all the required conditions, and this lamp is now commonly used as a standard in Europe. The standard candle is not found sufficiently accurate for exact experiment or test. Magnesium wire has been used recently with considerable success, and would seem to offer many advantages. The common fault of all the proposed standard lights thus far evolved is their failure in recording the spectrum values.

Light and Shade. Terms used in art to represent the blacks and whites of pictures with their varieties and values. A picture

Fig. 130.

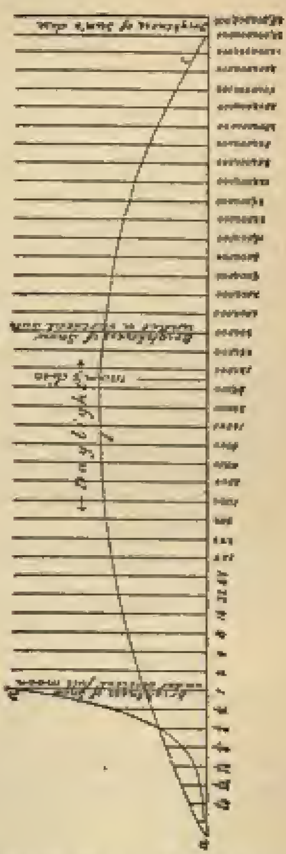
of a bunch of grapes, as in the Fig. 130, will illustrate this subject satisfactorily. The grapes may be considered as heads for the sake of illustration and viewed accordingly.

Light-Fog. (See *Fog.*)

Light for Enlarging. Should be small in dimension but concentrated in intensity and quality; the first to obtain sharpness, the latter to obviate the necessity of protracted exposure. An argand oil lamp is very convenient, as also is Marcy's lamp in which the two flat burners or wicks are turned end-wise to the condenser; any of the various forms of lime-light can also be used successfully. If daylight is employed a mirror or reflector placed under the light source, at an angle of 45°, will secure the desired concentration.

Light-Scale. Every human eye is sensitive (on conditions) to a varying range or scale of light which is simply astonishing for the mind to contemplate, and almost incredible were it not for the fact that it admits of such simple and cogent proofs. Fig. 131 represents the enormous light-scale to which the eye is sensitive. The brightness of pure snow under a vertical full

Fig. 131.



moon is taken as the unit. Each vertical line stands for a degree or grade of light intensity which is just double that of the grade represented by the next line on the left. At the left-hand end of the figure the curve at *a* represents the rapidly increasing value of the light-intensities represented, the height of any point of the curve above the base-line being proportional to the particular light-intensity, the unit line 1 being about one inch in height. The light in-

tensities corresponding to each line or grade are given in figures beneath (in round numbers). It has been demonstrated by experiment and agreeable to theory that the sun's face is intrinsically at least 500,000 times brighter than the face of the full moon, and therefore (since the sun and moon have about the same apparent diameter), pure snow illuminated by a vertical sun is at least 500,000 times brighter than snow illuminated by a vertical full moon. Therefore, if the line representing snow in moonlight in the diagram is just an inch high, then the line representing snow under a vertical sun should be about nine miles high in order to proportionally represent the relative intensity. But this is paltry compared with the line upward of 900,000 miles high, which, on the same scale, would represent the brilliancy of the sun's face itself. Scarcely any apology will be needed for not representing this diagram in its entirety.

Lightning Photography. Photographs of the various forms of lightning may be easily secured during a storm at night. The camera should be fixed rigidly, exposed to that part of the sky where the flashes are most frequent. The plate should be changed after a flash passes the field of view. A rapid lens, working at *f* 8 is the best for this work. Development of the plate should be gradual. Lightning photographs are valuable only when accompanied by the particulars attendant at the time of exposure.

Lignin. Cellulose. $C_6H_{10}O_5$. Foundation principle of plant-cells; insoluble in water, alcohol, ether, oils, and diluted acids. A nearly perfect form is purified cotton fibre, in which form it serves in the production of pyroxylin.

Lignin is pure woody fibre. It forms about 95 per cent. of baked wood, and constitutes the woody portion of all vegetables; its composition resembles starch, and by the action of oil of vitriol it is converted into dextrin or sugar, and a new acid (*ligno-sulphuric*). Strong nitric acid dissolves sawdust, and when the solution is diluted with water, a white insoluble powder is deposited, which explodes when heated.

Lime. An oxide of calcium, obtained by exposing limestone or chalk, which are carbonates of lime, to a red heat. The substance thus obtained is called *quicklime* or *stone-lime*. When water is poured upon quicklime it becomes very hot, and crumbles down into a powder—becomes "slaked."

The chemical formula is CaO. A white unmeltable mass, absorbing water when heated (dissolves), and breaking up into a white powder. Slaked lime ($Ca(OH)_2$) is not very soluble in water, and is of alkaline reaction.

Lime Accelerator. An aqueous solution of cane sugar saturated with lime has been proposed as a substitute for the alkali in pyro development. Lime-water (made by triturating one part of lime with twice its weight of pure sugar, manna, or glycerine; then adding 20 parts of water and decanting the clear solution) has also been suggested as an accelerator in development, but on account of the slowness of its action is not of practical use.

Lime-Light. Oxy-hydrogen light; calcium light (Drummond's). A piece of carbonate of lime made incandescent and intensely luminous by a burning mixture of oxygen and hydrogen gas. Used as a light-source for projections and enlargements.

Lines. The diagram exhibits the three great varieties of lines which appear more

FIG. 132.

or less in every photograph as follows: upright, horizontal, and wavy or tortuous lines.

Line Engravings, To Copy. The drawings or engravings to be copied should be evenly illuminated from each side, and so fixed that vibration is impossible. A good wide-angle lens carefully shaded with a cone lined with black velvet is the best objective for this purpose. The exposure should be carefully timed after focussing, inclining to a short rather than a long interval of time.

Develop the negative with pyro and sodium carbonate, well restrained with bromide. Clear the image, if required, with iodine and potassium cyanide, and if necessary intensify with mercuric chloride and silver cyanide.

Line-Negative. A negative from a line-drawing (not half-tone).

Linography. Photographing on woven fabrics; for paintings mostly.

Linseed Oil. This oil is produced from the seeds of Linum usitissimum et perenne, bruised or crushed, and then ground and pressed without heat. Pale, insipid, viscous; sp. gr. 0.9347. Linseed oil is used for making some varnishes, and in photographic engraving, mixed with litharge. The method is to apply a mixture of linseed oil, litharge, and ether to a metallic plate, expose the plate to sunshine under a negative for about an hour, then wash it with ether to remove the compound not affected by light, and lastly etching the plate with an acid.

Liquid Ammonia (Liquor of Ammonia). (See *Ammonia.*)

Liquid Color Screens. Sometimes used instead of a colored glass screen in orthochro- tic work; consisting of two plain glass ..ted together with a thin sheet of liquid uye between them. These screens may be placed within the combinations of the lens, and possess certain optical advantages. The name "panorthoscopic" was suggested for them by the inventor, Mons. Guillerninst.

Liquid Glue. Dissolve with a gentle heat the best quality of glue in acetic acid, No. 8. This glue is always liquid and ready for use.

Liquor. This term is applied to those aqueous solutions commonly, though improperly called waters, as liquor of ammonia, liquor of potassa, etc., which are simple solutions of pure potassa and gaseous ammonia, and would therefore be more correctly and intelligibly called solutions. The term *liquor* has also been applied of late years to some concentrated preparations more correctly termed *fluid extracts*, as they merely differ from *good* extracts in their less consistency, and from *ordinary* extracts in containing less starchy matter—albumen and gum. There is also usually a little spirit added to them to prevent decomposition.

Liquor Ammonii Caustici. Aqueous solution of ammonia.

Liquorice Sugar. Sweet-tasting gum, soluble in water and alcohol. Recommended in negative collodion for greater vigor.

Liquoscope. An instrument for comparing the refractive indices of liquids. Used to detect adulterations, etc.

Litharge. Litharge is prepared by scraping off the dross that forms on the surface of melted lead exposed to a current of air, and heating it to a full red to melt out any decomposed lead. The fused oxide in cooling forms a yellow or reddish crystalline mass, which readily separates into scales; these, when ground, constitute the powdered litharge of the shops. It is used by painters as a "drier" for oils, and for various other purposes in the arts. It is also used as a sensitive coating in photographic engraving. (See *Linseed Oil.*)

Lithium Bromide. Soluble in water and alcohol; sometimes used in preparing bromide emulsions.

Lithium Carbonate. Has been proposed as an accelerator in the development of gelatine dry plates. When used with pyro, in place of other alkaline carbonates, the developing solution is rendered more energetic and yet less liable to produce fog. The formula is given as follows:

Pyro	2 grains.
Carbonate of Lithium	2 "
Sulphite of Soda	12 "
Water	1 ounce.

Lithium Chloride. This chloride, occurring in confused deliquescent crystals, freely soluble in alcohol and water, is used chiefly in the preparation of gelatino-chloride emulsions.

Lithium Iodide. Soluble in alcohol and water; employed to iodize collodion.

Lithographic Ink, Preparation of. I. Mix, mastic in tears, 8 ounces; shellac, 12 ounces; Venice turpentine, 1 ounce; melt together, and add wax, 1 pound; tallow, 6 ounces; when dissolved, further add hard tallow soap, in shavings, 6 ounces; when the whole is combined, add lampblack, 4 ounces; mix well, cool a little, and then pour it into moulds or on a slab, and when cold cut into square pieces. II. Dry tallow soap, mastic in tears, and common soda in fine powder, of each 30 parts; shellac, 150 parts; lampblack, 12 parts; mix as first. Both these are used for writing on stone. III. (*Autographic.*) *a.* White wax, 8 ounces, and white soap, 2 to 3 ounces; melt; when well combined add

lamp-black, 1 ounce; mix well, and heat it strongly; then add shellac, 2 ounces; again heat it strongly, stir well together, cool a little, and pour it out as before. *b.* White soap and white wax, of each 10 ounces; mutton suet, 3 ounces; shellac and mastic, of each 5 ounces; lampblack, 3½ ounces; mix as above. Both these are used for writing on lithographic paper. When *a* is used the drawing or manuscript will keep for years before transferring; but when *b* is employed the transfer must be made within a week. These inks are all rubbed down with a little water in a cup or saucer for use, in the same way as common water-color cakes. In winter, the operation should be performed near the fire, or the saucer should be placed over a basin containing a little *warm* water. Either a steel pen or a camel's-hair pencil may be employed with the ink.

Lithographic Paper. This paper is used to write on with lithographic ink for the purpose of transfer to the stone. The writing may be transferred by simply moistening the back of the paper, and evenly pressing it on the stone, when a reversed copy is obtained, which is used to print from. Prepared in two ways: I. Starch, 6 ounces; gum-arabic, 2 ounces; alum, 1 ounce; make a strong solution of each separately in hot water, mix, and apply it while still warm, to one side of the paper, with a clean brush. When dry, a second and a third coat may be given; lastly press, to make it smooth. II. Give the paper three coats of good thin size, one coat of good white starch, and one coat of a solution of gamboge in water; the whole to be applied with a sponge, and each coat allowed to dry before the other is applied. The whole of the solution should be freshly made.

Litmus. A blue pigment prepared from the species of lichen called Lecanora tartarea, or Roccella tartarea. The ground lichens are first treated with urine containing a little potash, and allowed to ferment, whereby they produce a purple-red, which is again treated with quicklime and urine, and set aside to ferment for two or three weeks; it is then made into a paste with chalk or gypsum, and dried in the shade. Litmus has a violet-blue color, is easily pulverized, is partially soluble in water and dilute alcohol. The color is not altered.

In photography, the vegetable pigment litmus thus obtained is used as an indicator of acidity and alkalinity in various processes and manipulations.

A solution of litmus is prepared by gently boiling purified litmus with three times its bulk of spirits of wine for one hour. The fluid is poured off; the same operation is then repeated. Digest the residual litmus in distilled water, and filter the solution of litmus required. Blue litmus-paper is made by steeping unsized white paper in solution of litmus, and drying by exposure to air. Red litmus-paper is unsized white paper steeped in a solution of litmus which has been previously reddened by addition of a very minute quantity of acid, and dried by exposure to air. The coloring matter in litmus is azolitmin.

Litmus-paper. Blue litmus-paper is colored red by acids; the red, blue by alkalies. The latter remains red in neutral solutions.

For ordinary purposes it is more convenient and economical to buy commercial litmus test-papers, readily obtainable everywhere, than to prepare the paper oneself.

Liver of Sulphur. (See *Potassium Sulphide.*)

Losing Depth. Toning out; growing lighter in the bath.

Luminous Paint, Balmain's [illegible] a dry white powder ([illegible]) paint. After exposure [illegible] illuminating in the dark [illegible] for normal light in W[illegible] and is used in the preparation of self-illuminating photographs. Obtained by [illegible] sulphide of calcium and [illegible] combinations to red heat (glowing).

Luna Cornea. This salt is always formed when muriatic acid or any soluble muriate is added to a solution of nitrate of silver. It is also prepared when silver is heated in chlorine gas. (See *Chloride of Silver.*)

Lunar Caustic. (See *Nitrate of Silver.*)

Lunar Photography. The art of taking photographs by the light of the moon. This is accomplished by means of telescopes, with the other appliances of photography. (See *Astronomical Photography.*)

Lute. A composition employed to secure the joints of chemical vessels, or as a covering to protect them from the violence of the fire. *For the joints of vessels*, as *stills*, etc., not exposed to a heat much higher than 212° F., linseed meal, either alone or mixed with an equal weight of whiting, and made into stiff paste with water, may be employed. Ground

almond cake, from which the oil has been pressed, may also be used for the same purpose. *For the joints of small vessels*, as tubes, etc., especially of glass or earthenware, small rings of India-rubber slipped over and tied above and below the joint, are very convenient substitutes for lutes, and have the advantage of lasting a long time and bearing the heat at which the oil of vitriol boils. *For joining crucibles* to be exposed to a strong heat, a mixture of fine clay and ground bricks, mixed up with water, or preferably with a solution of borax, answers well for most purposes. *As a coating for vessels*, to preserve them from injury from exposure to fire, nothing is better than a mixture of pipe clay and horse-dung made into a paste with water. It is applied by spreading it on paper.

M.

Maceration. In chemistry, the infusion of a substance in water for the purpose of extracting the portion soluble in that menstruum. The word is also applied to the infusion of organic substances in alcohol, ether, or water, either alkalized or acidulated.

Machinery, Photographing. To obtain good photographs of machinery the subjects should be painted a dull-gray color. The lens used should be a medium wide-angle, well stopped down before exposure. The light should come from the top and front, and a generous exposure should be given. These details having received attention, the usual procedure may be followed.

Macrophotography. The production of an enlargement from a negative in the solar camera.

Madison's Negative Varnish. This varnish dries quickly and perfectly hard; is not softened by the hottest sun; does not crack with heat or age, or detach itself from the glass, even if accidentally wetted; resists damp, and gives a thin, clear coat that will bear any amount of rubbing, without injury to the negative—conditions all absolutely necessary to a good varnish, and which few possess. *To make*—Take bleached shellac, 1 ounce; gum benzoin, 3 drachms; gum juniper, 1 drachm, or less; soda borax, 1 drachm. Powder and dry them and dissolve in alcohol 800°, to the proper consistence. This must be filtered. *To apply*—The back of the plate must be warmed and the varnish poured on warm and dried before the fire. The surface is like glass to the touch.

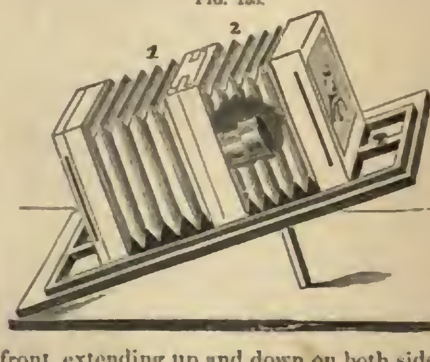
Magazine Camera. There are several forms of magazine cameras. They are provided with thin metal leaves, twelve or more in number, all hinged or linked together in carriers. These links are pivoted together by small rods, the ends of which project about ⅛ of an inch at each side. These projecting ends travel in a slot in a metal plate on the inner side of the box, and these slots form the guides in which the hinges travel. The lens and the shutter are in the front end of the box.

Magazine Drawer. That part in a hand-camera with arrangement for changing plates which contains the latter. It is either embodied in the camera, or removable. Many hand-cameras have a double magazine.

Magic Lantern. An apparatus resembling a camera obscura, but supplied with an air-draught. In this apparatus the rays of a powerful artificial light-source, after passing through a condenser, are thrown upon small glass transparencies, which, by a system of convex lenses, are projected upon a white screen.

Magic Lantern Slide Camera. A camera box, No. 1, having a movable front, is used for exposing the plate. On the edge of the

FIG. 133.



front, extending up and down on both sides, is screwed a piece of wood making a groove into which an extension of camera box No. 2 slips, having a flange on its edges corresponding to the grooves in No. 1. Box No. 2 is made with a large opening in the front or part adjoining No. 1. The upper end,

instead of having a grooved glass, has an opening arranged to fit the negative with a dark-slide immediately behind. This box has a bellows and rack adjustment as with other cameras. It should be made to extend at least 30 inches. To put the box in working order, remove the movable joints of No. 1, on which the lens is fastened. Then push them together, joint to joint; pull out the dark-slide of No. 2, and adjust the front of No. 1 in its position. Then place the negative in the frame of No. 2, inclining all so that the line of vision will strike the sky or any white object. A long platform will be found convenient as a stand for this apparatus. A north exposure is best. The lens in No. 1 must always be uncovered, using the slide behind the negative as a covering.

Magic Photographs. Make a print on albumen paper in the usual way, fix and wash thoroughly without toning, immerse the print in a saturated solution of bichloride of mercury until the image disappears; wash and dry. To make the invisible image appear, place the picture in contact with a moistened sheet of absorbent paper which has been previously soaked in a saturated solution of hypo soda, when the image will reappear with all its pristine vigor, as if by magic.

Magnesia. A light, white substance, classed with the earths. It occurs both in the organic and inorganic kingdoms. It was discovered, or at least first chemically distinguished from lime, by Dr. Black, in 1755. Pure magnesia is properly the oxide of the metal magnesium.

Magnesia, Carbonate of. The carbonate of magnesia of commerce is usually made up into cakes or dice. It is a white, inodorous, tasteless powder, possessing similar properties to calcined magnesia.

Magnesium. Mg. A silvery-white, somewhat brittle metal, obtainable commercially in the form of ribbon, wire, and powder. In 1859 Bunsen demonstrated the utility of magnesium as a source of light for photographic purposes. It is now largely used for securing photographs of mines, caves, and interiors, also in portraiture and group photography. (See *Artificial Lighting*.) The wire or ribbon may be burnt in a spirit lamp or gas-flame. The powder, either in a pure state or in combination with other substances, is generally projected through a flame by air-pressure, or ignited in a heap upon a metal plate or other suitable receptacle. Many magnesium-light compounds are dangerously explosive and require great care in handling them. The light produced by all the above forms of magnesium is very intense and possesses great actinic power, permitting of instantaneous exposures.

Many different varieties of apparatus for the combustion and distribution of pure magnesium and magnesium-light powders have been introduced, details of which may be seen by reference to the catalogues of dealers in supplies.

Magnesium, Bromide of. Prepared by dissolving magnesia in hydrobromic acid and evaporating to dryness.

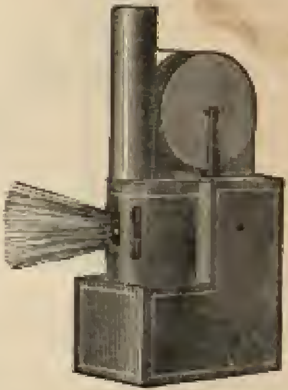
Magnesium, Chloride of. This salt is best prepared by dissolving magnesia in muriatic acid, evaporating to dryness, adding an equal weight of muriate of ammonia, projecting the mixture into a red-hot platinum crucible, and continuing the heat until a state of tranquil fusion be attained. On cooling it forms a transparent, colorless, and very deliquescent mass.

Magnesium, Fluoride of. Is obtained by dissolving magnesia in hydrofluoric acid and evaporating to dryness.

Magnesium, Iodide of. Is prepared by dissolving magnesia in hydriodic acid and evaporating to dryness.

Magnesium Lamp. One of the many contrivances used for burning metal magnesium ribbon, for photographic and lantern illumination. The metal ribbon is rolled upon a reel, shown at the top of the lantern,

FIG. 134.



and by clockwork inside is fed to the exit in front, as the metal is consumed by the flame.

Magnesium, Sulphate of. Better known as Epsom Salts. Is used as a preventive of frilling. The bromide and iodide of magnesium are employed as iodides for collodion, and chloride of magnesium has been proposed as a fixing agent for gelatino-chloride prints; a mixture of 15 parts of this chloride in 100 parts of water, with 2 parts of alum, is employed for this purpose. It is also employed in the preparation of gelatino-chloride emulsions.

Magnetometer. An instrument to ascertain the force of magnetism.

Magnified Photographs. Small negatives enlarged by means of transmitted light upon prepared paper, canvas, or other substance. (See *Enlarging Photographs; Solar Camera*, etc.)

Magnifying-Glass. Used by negative retouchers and supplied with a "James lens-support," illustrated herewith. By means

FIG. 135.

of the ball clamp shown in the cut the lens can be adjusted and fixed in any desired position.

Malachite-Green. A solution of malachite-green has recently been recommended as a color-sensitizer for orthochromatic purposes, rendering plates bathed in a mixture of malachite-green and naphthalene-blue sensitive to red, yellow, and green rays.

Malic Acid. Juice of the fruit of the mountain ash immediately after it has turned red, but still unripe. Malic acid is very soluble in water, has a pleasant acidulous taste, and, when neutralized with the bases, forms salts called *malates*.

Malt. Grain which has become sweet in consequence of incipient germination. Barley is the grain usually malted, and the process consists in exposure to warmth and moisture.

Malt Preservative Process. In Macnair's preservative process, and in others, malt was used as a preservative.

Manganese. A hard, brittle, grayish-white metal, having the sp. gr. 8.013. It is obtained by reducing the black oxide of manganese to a fine powder.

Manganese Binoxide. MnO_2. Syn., Black oxide of manganese. Occurs as a black crystalline powder, and is used for the production of oxygen for the lime-light.

Manipulate. To treat, work, or operate with the hands.

Manipulation. Working with the hands; manual operation; the operation of preparing substances for experiment.

Marble, Photography on. To obtain photographs on marble, take an unpolished plate of marble; must be coated with a solution of benzine, 500 parts; spirits of turpentine, 500 parts; asphaltum, 50 parts; and pure wax, 5 parts. When this is dry the plate is exposed under a negative, which will take, in sunshine, about twenty minutes. Develop with spirits of turpentine or benzine, and wash in plenty of water. The next step is to cover the plate where it is intended to be left white, with an alcoholic solution of shellac, and immerse the same in any dye which is soluble in water. After a while, when enough of the coloring matter has entered the pores of the marble, it is taken out and polished.

Marcellus Cycloramic Camera. This camera was designed, as indicated by the name, to make a complete panorama of the scene surrounding the point from which the picture is taken, with one exposure. This object is accomplished by a mechanism which causes the simultaneous movement of the camera and film—that is to say, when the camera moves in one direction the film, while being carried along with and inside the cam-

era, moves from one roller to another in the opposite direction, accurately receiving the image as it is presented by the lens. The camera revolves on a pivot or iron post directly below the centre of the lens. Rigidly attached to the same post is a grooved wooden disk, the radius of which is equal to the focus of the lens. Cut in the edge of the disk is a slot in which is clamped one end of a narrow belt of film, the other end of which has been previously clamped in a slot cut

Fig. 136.

longitudinally in the end of a "feed" roller, which projects through the bottom of the camera, and automatically wrapped around it as many times as the film inside the camera is wrapped around the upper portion of the "feed" roller. Below the wooden disk and revolving on the iron post is a bifurcated arm, the other end of which is connected by an upright brace to the bottom of the camera. To this arm is attached the outer end of a heavy spring, the inner end of which is fastened to the iron post. The recoil of this spring causes the revolution of the camera, and is controlled by a gear train with a fan governor, the first wheel of said gear train being fastened to the bifurcated arm, and revolving with it. The said spring is wound up by pushing the camera around with the hand, and is prevented from recoiling by a ratchet and pawl device, the pawl being released when all is ready to make the exposure. The focus of the lens is fixed at a point directly above the periphery or edge of the wooden disk, and a trifle to the right of the point at which the lid in the illustration is hinged. The portion of the camera covered by the hinged lid contains the rollers around which the film passes. These rollers are four in number, viz., a spring-controlled "feed" roller, a spring-actuated "receiving" roller, and two small guide rollers, the last being so placed that the film when passing over them will be in the focus of the lens. The feed and receiving rollers have pins or trunnions with square heads in their upper ends which detachably fit in similarly shaped holes in the axles of the spring devices on the outside of the lid of the camera. The device above the "feed" roller is to prevent the film from being unwound too rapidly, and the one above the receiving roller is to cause the film to be wound thereon as it is paid out by the "feed" roller. The film when placed in the camera is wound on the receiving roller, which is contained in a brass light-tight cylinder. When the camera is pushed around to wind up the motive spring, the film is drawn from the cylinder and wrapped around the "feed" roller by the automatic action of the spring above the said "feed" roller, which is left free to act, while at the same time, outside the camera, the belt of film is being unwound from the groove in the wooden disk and wound upon the projecting end of the "feed" roller. When the exposure is made the film is wound back in the light-tight cylinder, which may be replaced by another.

This ingenious apparatus was invented in 1893 by Percy Shelley Marcellus, Philadelphia.

For a full description and a view of the Columbian World's Exposition made with the Marcellus camera see *Wilson's Photographic Magazine*, May, 1894.

Marginal Definition. The sharpness of an optical picture extending to the edges.

Marine Glue. Mixture of caoutchouc solution with powdered shellac, in form of

plates, or black-brown mass, to be heated before use. Used for making wooden trays, etc., water-tight. Substitute for asphaltum in etching processes.

Marking on Collodion Pictures. These troublesome visitors are of various kinds, viz.: *A reticulated appearance on the film after developing*, the result of collodion containing water, or the plates may have been immersed too quickly in the bath, and the soluble pyroxylin partially precipitated. *Oily spots or lines;* from raising the plate out of the bath before the immersion has been sufficient to thoroughly wet the film; or from removal of the plate from the bath before the ether on the surface has been washed away; or from re-dipping the plate in the nitrate bath after exposure to light, and pouring on the developer *immediately;* or from the nitrate bath being covered with an oily scum, which is carried down by the plate. *Straight lines traversing the film horizontally*—from a check having been made in immersing the plate in the bath. *Curved lines of over-development*—from employing the developer too strong; or from not pouring it in quick enough to cover the surface before the action begins; or from using too little acetic acid and omiting the alcohol. *Stains*—from too small a quantity of fluid having been employed to develop the image. *Irregular striæ*—from fragments of dry collodion accumulating in the neck of the bottle, and being washed in the film. *Markings*—caused by using an inferior sample of pyroxylin made from too hot acids, and most seen when using an old bath. *Stains on the upper part of the plate*—from using a dirty slide. *Wavy marks at the lower part of the plate*—from the collodion becoming too thick and glutinous; or from reversing the direction of the plate after its removal from the bath, so that the nitrate of silver flows back again over the surface; or from impurities on the woodwork of the frame ascending the film by capillary attraction. *Marks*—from the developer not running up to the edge of the film.

Martin's Albumen Negative Process. To the white of eight eggs M. Martin adds

Iodide of Ammonium . .	1 drachm.
Sugar of Milk	1 "
Dextrin	15¾ grains.
Grape Sugar	24 "
Distilled Water	6¾ drachms.

beating them up in the usual way, leaving it to stand over night. For landscapes he doubles the quantity of iodide, and in wet weather omits the grape sugar. The plates when sensitized, if well washed, will keep ten days, and after exposure in the camera may be kept nine days before developing, with a saturated solution of gallic acid, to which a few drops of a 4 per cent. nitrate solution have been added; this must be done on a sheet of copper well heated.

Martin's Intensifying Process. This process is intended or positive collodion proofs (ambrotypes) copied in the camera from negatives. A plate worked with wet collodion by the ordinary method is developed with dilute sulphate of iron; the developed proof is carefully washed, and before fixing it is covered with a solution of bichloride of mercury. Decomposition immediately ensues, giving rise to protochloride of mercury and chloride of silver; a small quantity of mercury set free fixes itself on the silver of the picture. When carefully washed a solution of cyanide of potassium or hyposulphite of soda previously saturated with silver is poured over the plate; it is left to act for a few seconds, the traces of the mercury adherent to the film decompose the double salt contained in these solutions, and cause a precipitate of metallic silver in a finely divided state, which gives a very fine coloring to the picture. The operation is concluded by fixing in the ordinary manner, preference being given to hyposulphite of soda in a state of concentrated solution; and, after sufficient washing, the picture may be transferred by means of gelatined or albumenized paper.

Mascher's Stereoscope. This consists of a bottom to rest the pictures upon, and a top holding the lenses, supported by pillars at the four angles. The spaces between the pillars at the sides and ends are furnished with glass, through which to admit the light.

Mascher's Stereoscope Case. This is simply a daguerreotype case with a flap attached to the inside of the cover, in which the lenses are placed.

Mascher's Stereoscope Medallion. This instrument consists of a locket or medallion case with supplementary lids, containing each a lens, and so arranged as to fold within the picture-lids, and in such relation to the latter that upon being opened and adjusted the lenses stand opposite the pictures.

Masks. Leaves of black paper with oval, round, or square cut-outs in the middle, and so placed over the negative as to allow only

that part of it to print which corresponds to the cut-out, leaving a white margin all around. Usually, when printed deep enough, the mask is removed, and the piece cut out of it (disk) is placed over the printed portion to tint the margin by a second exposure.

Mastic Mastich. A species of gum or resin, much used for varnish.

Matt. The metal, paper, or velvet border surrounding the picture, and placed between the plate or paper and glass, to preserve the two latter from contact when put into a case or frame.

Matt-Surface Prints. Prints with a matt, or plain unglazed surface, may be obtained by using a paper without gloss, such as plain silver paper; or by using a prepared matt-surface chloride paper; or by squeegeeing a brilliant-surfaced paper upon finely ground glass; or by flowing a glossy print with ground-glass varnish before the final mounting. The platinotype, bromide, and plain-paper processes are those most generally used for the production of matt-surface prints.

Matt Varnish. A negative varnish consisting of a solution of sandarac and mastic in benzole and sulphuric ether, etc., applied cold to the plate, showing, when dry, a grained matt film, taking the retouching pencil well. Used also for backing those parts of the negatives which would print too deep without it.

Mattalein. A varnish made of 1 part of gum dammar and 5 parts of turpentine, for negatives that have to be retouched. It gives tooth for the pencil.

Matter. The general name applied to that which, under an infinite variety of forms, affects our senses. The term *matter* is applied to everything that occupies space, or that has length, breadth, and thickness.

Mayall's Albumen Negative Process. In this process everything depends upon the care with which it is conducted. Hen's eggs are the easiest of access, and they must be perfectly fresh.

Cleaning the Glass.—Make a solution of

Alcohol	1 ounce.
Aqua Ammoniæ	2 drachms.
Water	1¾ "
Tripoli	1 ounce.

with which clean the glass thoroughly with hard balls of cotton wool, finishing with dry patches of cotton flannel.

Spreading the Albumen.—To prepare the albumen, take

Albumen	127½ fluid drachms.
Saturated solution Iodide of Potassium	2 drachms.
Saturated solution Bromide of Potassium	25 minims.
Solution Caustic Potash	1 minim.
Water	17 minims.

—the iodide and bromide should be each a saturated solution in distilled water, at 60°, and the proportion must be carefully preserved. Put the ingredients in a half-gallon, wide-mouth bottle and shake up until the bottle is completely filled with white foam. Let it stand six hours in a cool place, then pour off the clear albumen into a tall glass measure, tapering from the bottom to the top, about one hour before using. It is now necessary to avoid most carefully any air-bubbles. To do this, take a glass funnel with a long beak that just reaches to the bottom of a pint measure, upon which place a flat plate of glass turned up at the edges, with a hole in the centre; the whole is lined with moistened muslin, so that when the albumen falls upon the glass dish in the act of pouring, it glides gently down into the glass measure placed under. Support the funnel with a filter-stand. Also place a wet sponge covered with clean muslin on a table near at hand. Take a cleaned plate of glass, balance it on the tips of the fingers of the left hand, brush off the dust, and from the measure of albumen pour on sufficient to well cover the plate; keep it as level as possible, then suddenly turn it down on its edge, to allow the excess of albumen to run into the glass dish; wipe it carefully eight seconds on the edge of the muslin, then eight seconds on the sponge cushion, and place it in the drying-box. If too much albumen is allowed to remain on the plate it will be streaked and uneven, and if too little is used the proof will be thin and weak. The plates will be perfectly dry in three days; put them in boxes in a dry place, where they will keep for any length of time.

To Iodize the Plates.—The plates will now have to be passed over the vapor of iodine, just like a daguerrotype plate, to completely saturate the alkaline reaction; this will take from two to four minutes, according to the temperature; the albumen surface ought to receive a yellow tinge by the vapor of iodine; this operation ought to be done a few hours before silvering.

Silvering the Plate.—Prepare the bath with

Water	53 ounces.
Nitrate of Silver	2325 grains.
Glacial Acetic Acid	42½ drachms.

Filter. Use two baths and a bath of distilled water, and so arrange the dipping that the plate remains in each nitrate bath one minute and a half; then place it in the distilled water; then wash the back with common water and the face with distilled; rear up to dry in a place free from dust. Renew the silver bath by adding 465 grains of nitrate of silver for every 100 plates sensitized, and 340 minims of glacial acetic acid, with sufficient water to make up the original quantity.

To Prepare the Plate for the Camera.—Pass it over the vapor of iodine for about half a minute previous to placing it in the slide; expose in the camera from thirty seconds to ten minutes, according to the intensity of the light, the color of the object, and the aperture of the camera; if required to be very quick the plate should be plunged into a bath of gallic acid—1 part of acid to 10 of water. This is for plates to be used immediately.

To Develop the Image.—Make

B. A saturated solution of Gallic Acid.

C.	Nitrate of Silver	465 grains.
	Water	14½ ounces.
	Acetic Acid	1280 minims.

A pint bottle filled with 3 parts of gallic acid solution, B, and 1 part water; pour into a dish, kept expressly for the purpose, about half an inch of liquid in depth; drop into it 8 drops of solution C and shake up; then run distilled water on to the plate from the camera, and plunge it into the gallic acid; shake it about, fill the dish with plates, and continue to shake up, and add every hour 8 to 20 drops of the solution C until the image is fully developed. The operation may be continued with safety three days, if necessary, though it is best to complete the development in twelve to sixteen hours. Wash well with water, and rear up to dry. A quicker method of developing is with—

Water	85 drachms.
Pyrogallic Acid	15¾ grains.
Glacial Acetic Acid	85 minims.
Formic Acid	17 "

The plate will develop in half an hour in this solution, and in warm weather in less time; but the half-tones are not so well preserved as in the slow process.

Fixing.—The fixing solution should be kept entirely apart from the albumenizing; in fact, it should not be in the same room. Take—

Water	100 parts.
Hyposulphite of Soda	10 "

Dissolve and filter. Continue the fixing until all the yellow iodide disappears; wash well and dry.

Positive Plates are prepared in the same way, only substituting chloride of sodium for the bromide of potassium.

Mayall's Artificial Ivory. This substance is better adapted to photography than the real ivory. It is made by mixing albumen and sulphate of baryta mechanically into a fine paste and then rolling it out into slabs of the required size, and polishing either surface with very fine emery and leather, and afterward with finely powdered charcoal, and finally with soft buckskin or soft kidskin.

Measles. An affection common to albumenized paper. Measles are of two distinct characters—one, where, when the paper goes into the gold toning-bath, it seems as if the surface was in a flocculent state, minute raised fibres receiving less albumen than the hollow parts, consequently toning first, so that if it be pushed sufficiently to get the red, slowly toned parts subdued to a purple black, the fibrous parts will have gone into a cold leaden gray, thus giving a flat, mottled appearance to the fixed picture when toned in a common neutral or slightly alkaline bath. The second description, which is generally the result with beginners, is a poor, weak, foggy sort of print, without any strength or contrast; it is seen in the pressure-frame before it goes into the gold, and turns rapidly gray in the toning, and when fixed and dry has no sharpness, and seems as if it had been sprinkled all over with sand. This is either the result of starting with too weak a silver bath, or not making sufficient allowance for the amount of silver decomposed in it. For the new toning process the bath ought to be at least 70 grains to the ounce, so that it will be much the best to start with 80 grains; every three sheets will take half an ounce of liquid, containing 40 grains, besides 72 grains decomposed by the salt; we have, therefore, only to make a solution of 112 grains to the half-ounce of water and add after every three sheets, and add as much after every three sheets to keep up the

strength of the bath. This weak effect of the picture is also produced by not stirring up the bath after every piece is taken off of it; suppose the liquid in the dish is a quarter-inch deep, if two or three sheets are put on and carefully taken off, the silver is decomposed from the surface as well as the liquid abstracted, and from the high gravity of the nitrate, the upper stratum is almost water. As preventive remedies, the albumenized paper may be rolled before and after albumenizing and be dried in hot air; but it is not possible always to prevent it, so that our only recourse is to learn the best method of treatment during the manipulation. It certainly stands to reason that the best remedy would be to prepare a bath for toning that shall tone to a certain good color and go no further, but allow the slow-toning parts to catch up the first toned, and so make the whole uniform. The whole secret is to discard the plain alkaline bath altogether, and to use an organic salt of gold. One grain of citric acid to every grain of chloride of gold, neutralized after mixing with carbonate of soda, will be quite sufficient to produce the effect required; the acid will keep any length of time in solution, by putting a small piece of camphor into the bottle; it is convenient to keep the acid and soda in solution in separate bottles, both of the strength of 2 grains to each drachm of water. It must not be supposed, however, that without care, this will always get rid of the measly effect; the paper must be watched while toning, and removed if very bad, directly the purple tone is reached in the quickest toned parts; never mind the measles looking bad at this stage; they will disappear after fixing and drying. The great fault almost always is over-toning the print; in endeavoring to get the red mottles toned, operators go on until the ground color is completely gray, whereas, if they stopped as soon as the purple was just reached, the print would be of a rich, warm tone and the measles hardly perceptible. The organic salt of gold has, however, great power of giving depth and richness—hardly ever, without pushing very much, going into the cold stage, so that it is very preferable in the normal solution. It is a great mistake to pile on the gold, this resulting in burying fine details of the shadows in *mud*. The whole secret of fine prints is in observing the maxim "plenty of silver and very little gold."

Measly. An expression used of prints lacking in vigor and brilliancy, and showing the condition described in the preceding article. Usually caused by a too weak silver bath.

Measure. The unit or standard by which we estimate extension, whether of length, superfices, or volume. The English imperial measure is that in general use in the United States; but the French measures frequently occur in both English and American works on photography; therefore, both systems are given here.

Imperial Measure.

60 minims (♏)	=	1 drachm.
8 drachms (ʒ)	=	1 ounce.
20 ounces (℥)	=	1 pint.
2 pints (O)	=	1 quart.
4 quarts (Oij)	=	1 gallon.

A wine pint of water measures 16 ounces and weighs a pound.

A minim is one drop.

An imperial gallon of water weighs 10 pounds avoirdupois, or 70,000 grains.

An imperial pint of water weighs 1¼ pound avoirdupois.

A fluidounce of water weighs 1 ounce avoirdupois, or 437.5 grains.

A drachm of water weighs 54.7 grains.

French Measures of Volume.

1 litre	=	10 décilitres.
	=	100 centilitres.
	=	1000 millilitres.
	=	35¼ English fluidounces.
	=	1 cubic décimetre.
	=	1000 cubic centimetres.

1 cubic centimetre = 17 English minims.

A litre of water weighs a milligramme, or something less than 2¼ pounds avoirdupois.

A cubic centimetre of water weighs a gramme.

Measurement of the Chemical Action of Light. (See *Photometer*.)

Medals, Prints Direct from. Immerse linen, cotton, or preferably silk, in a fairly strong solution of nitrate of silver, and when almost dry, stretch, in close contact, over the surface of a silver coin or medal. In a little while the design appears on the fabric. Simple washing with water removes the decomposed silver from the fabric, and the design remains stained therein.

Medical Photography. The applications of photography in medical and surgical

science are so numerous and of such importance that they can only be briefly referred to in a work of this kind. As employed in this direction photography is generally divided into two classes: macroscopic photography and photo-micrography. Under the heading of macroscopic photography is included the photographing of living patients in hospitals, photographing the cadaver before or during post-mortem examination; photographing morbid tissues after removal from the patient. Photo-micrography is the photography of subjects as enlarged under the microscope, and the photographic work in bacteriology, the results thus obtained being, of course, more reliable than those produced by hand drawing.

Media, Medium. The space or substance through which a body passes or moves to any point. Thus, ether is supposed to be the *medium* through which the planets move; air is the *medium* through which bodies move near the earth; water, the *medium* in which fishes live and move; glass, a *medium* through which light passes.

Medium (size). A term applied to the second sized camera, and the fourth sized case, matt and preserver.

Medium for Oil Colors. It is frequently wished that mere transparent glazings of oil colors over photographs, producing, as they do so charming an effect with so extremely small an expenditure of time and pains, were permanent enough to be adopted. The following medium will answer the purpose: Take ½ an ounce of gum anime and 1 ounce of gum sandarac, and reduce them to a fine powder, put them into a glass vessel containing spirits of wine, expose to the sun until dissolved, and then filter into a bottle for use.

Megilp. A compound substance used by painters to apply their glazings with. It is prepared by mixing mastic varnish 1 pound with pale drying oil 2 pounds. It may be thinned by adding turpentine. The properties may be varied according to the work to be done.

Meir's Clearing Liquid. Water 1 ounce, hydrochloric acid 2 drachms, iodine a few grains. Rub the plate with a circular motion with a pad saturated with the liquid; polish off as usual, and store till wanted in metal plate-boxes.

Meissenbach Process. The first practical process for producing pictures in half-tone from photo-engraved relief block, suitable for printing in an ordinary printing press; was patented by the Meissenbach Company. The method used in the production of blocks by the Meissenbach process is very similar to that employed by all half-tone photo-engravers, the use of a ruled screen-plate being its essential feature.

Melainotype. A positive collodion picture made upon black enamelled iron plates.

Meniscus. A lens convex on one side and concave on the other, having the concavity less than the convexity.

Menstruum. A term applied to the act of developing the daguerrean image over mercury. (See *Bringing Out the Picture.*)

Mercuric Chloride Intensifier. (See *Intensification.*)

Mercuric Oxide. Peroxide of mercury; red precipitate. There are two of these: the sub-oxide $= Hg_2O$, of black color, and the oxide $= HgO$, of red color. Both form salts.

Mercurography. A process by Villon for making printing-blocks for copper, stone and book printing by the aid of amalgams, on the principle that quicksilver has the property of attacking all metals except iron and platinum, and forming amalgams with them, and the amalgamated parts of a plate repelling fatty printer's ink.

Mercury. The only metal that is liquid at common temperature; it evaporates also at common temperature, and in this way serves as developer in the daguerrotype process. It combines with various metals, forming amalgams.

Mercury Intensifier. A weak solution of bichloride of mercury in water, which in connection with a solution of sulphite of soda and ammonia is used as an intensifier or strengthener of thin negatives.

Meta-Bisulphite of Potassium. $K_2S_2O_5$. This substance, little known or used in America, is made by saturating a strong solution of potassium carbonate with sulphur dioxide gas, and adding absolute alcohol to the liquid, when the salt will separate in needle-like crystals, soluble in three times their weight of water. It is employed in Europe largely for all purposes for which sodium sulphite is used here, viz., for preserving pyro, eikonogen, etc.

Metagelatine. Gelatine having its condition altered by heat, and being converted into a new substance, which change is not yet fully understood. It can be made by

taking 1½ ounces of pure white gelatine and dissolving it in 10 ounces, by measure, of boiling water in a porcelain capsule. When thoroughly dissolved add to it 60 minims of strong sulphuric acid, which has previously been diluted with 2½ ounces by measure of distilled water; boil for five minutes, then remove the capsule from the fire and allow the liquid to cool completely. Then heat it up again to boiling for five minutes, and again let it cool; this time it will most probably not gelatinize, but should it do so another warming up and subsequent cooling will be sure to bring it to the necessary condition. When the liquid no longer sets on cooling the acid must be neutralized by the addition of powdered chalk or whiting till effervescence no longer takes place, and the sulphate of lime thus produced must be removed from the liquid by squeezing it through a piece of fine linen.

Metagelatine Dry Process. This process is the invention of Mr. Maxwell Lyte, but we are indebted to Mr. Featherston for the practical details. The plan he has adopted with success for working is as follows: He uses a bath made of

1.	Nitrate of Silver (pure)	1 ounce.
	Distilled Water	2 ounces.
2.	Iodide of Ammonium	2½ grains.
	Iodide of Potassium	5 "
	Bromide of Cadmium	2½ "
	Distilled Water	1 ounce.
3.	Nitrate of Silver (fused)	10 grains.
	Distilled Water	1 ounce.

Mix solutions Nos. 2 and 3 by pouring No. 2 into No. 3, and having well washed the precipitate upon a filter add it while moist to No. 1, to which also add 13 ounces 5 drachms distilled water and 4 drops of pure glacial acetic acid. Leave this solution for a night in a bottle; in the morning filter; add 3 drachms alcohol, sp. gr. 800.

The Collodion:

Pure Ether, sp. gr. 730	20 ounces.
Alcohol, sp. gr. 800	8 "
Celloidin	64 grains.
Gun-cotton	64 "

Shake the collodion well until the pyroxylin is thoroughly dissolved; allow it to stand for two or three days, and then draw off the clear collodion with a siphon.

Iodizing Solution:

Alcohol, sp. gr. 800	4 ounces.
Iodide of Potassium	64 grains.
Iodide of Ammonium	32 "
Bromide of Cadmium	32 "

Reduce the iodides and bromide to powder, add them to the alcohol; keep this solution in a stoppered bottle. It is better to make it as required, but it will keep some time. Iodize 8 ounces of collodion at a time, thus: In a clean stoppered bottle place a sheet of silver leaf, and drop upon it 8 drops of strong tincture of iodine; allow it to remain five minutes and then pour upon it 7 ounces of the plain collodion, to which add 1 ounce of the iodizing solution; shake well together, allow it to stand over night and then draw off with a siphon. When about to use it add 10 minims of pure chloroform to each ounce of iodized collodion. The *preservative solution* is made as directed in article *Metagelatine*, which see.

Having now the bath, collodion and preservative solution, procure accurately cut plates of glass, and grind $\frac{1}{16}$ inch of the upper edge all round; clean with dilute nitric acid. Coat and sensitize as usual. When removed from the bath drain the plate pretty closely, first on the edge of the bath, and then standing on one corner upon blotting-paper, being careful that the plate does not dry on any part. Then attach a plate-holder (all the coatings must be performed on separate holders), and pour on the metagelatine at one of the upper angles, and flood it carefully from there to the opposite angle. Use two small precipitating glasses, one always to have fresh metagelatine in it, and the other to receive the old solution when poured off the plate; the first coat must always be thrown away altogether, and not returned to the measure; the second and third coat may be poured into the second measure, and may be used for the first coating of the subsequent plates, always giving the second and third coating from the fresh metagelatine; thus a very little of the solution will last a long time. When drained from the metagelatine, stand the plate on one end in the drying-box, keeping up a moderate heat; but if too much heat be applied the plates will blister and be spoiled. The *exposure* rarely exceeds one minute. The *development* must be carried on in perfect chemical darkness.

Place the plate upon a holder, and pour water over it for some minutes, until the gelatine is thoroughly softened; if this be not done, red stains will appear all around the plates. In a graduated measure place the following:

Distilled Water	2 ounces.
Pyrogallic Acid	½ drachm.
Glacial Acetic Acid	2½ drachms.
Formic Acid	½ "
Alcohol 80°	6¾ "

Then fill up the measure to the 5 oz. mark with distilled water. For use, add 1 drachm to 7 drachms. Pour this on the plate as soon as the washing is completed, and afterward pour it on and off two or three times; add 6 drops of a 40-grain silver solution, and proceed with the development. Never use an old bath for developing, as it frequently produces stains. The development ought to be complete in about twenty minutes; wash well, fix with cyanide, then wash thoroughly, afterward re-develop for a moment or two, dry quickly, and varnish.

Metal Etching Processes. Under this generic name may be combined all the photomechanical processes for the production of printing-plates in which metals, as copper or zinc, are used as the base.

Metaldehyde. The volatile prismatic crystals that form in aldehydes when kept at ordinary temperatures. It is soluble in alcohol.

Metallic Spots. Spots of zinc, copper, etc., frequently appear in paper from the imperfect condition of the rollers by which it is calendered. These spots give the photographer much trouble in his printing operations. Such paper should be treated in the following manner: Dissolve 20 parts citric acid in 200 parts of distilled water. Pour the solution into an earthen or porcelain dish (the bath should be abundant, so that the paper may swim freely in it; the action is hastened by the application of gentle heat); allow several sheets to remain in it for an hour or two, then remove them, and place them in another dish containing water rendered alkaline by 5 per cent. of ammonia; wash finally in pure water, and suspend by one corner to dry, thoroughly protected from the dust.

Meteorological Photography. Photography applied in meteorology does important service in recording automatically the readings of the instruments used in meteorological observations. The photography of clouds with relation to their forms and motion; the photographing of the solar spectrum, and the prediction of weather changes, all fall within this department of photography.

Methylaniline. Obtained by the action of caustic soda and methyl chloride; is used in the manufacture of methyl-orange, which is employed in chemical analysis as an indicator of acids or alkalies.

Methylated Alcohol. Syn., Methylated spirit. A rectified spirit to which 10 per cent. of wood naphtha has been added to prevent its use as a beverage. It is sometimes called wood alcohol. It is useful for the preparation of varnishes, drying negatives, and similar uses where the pure alcohol is not necessary.

Methylated Ether. Ether prepared in the usual way, except that methylated alcohol is used instead of pure alcohol. It is quite as satisfactory for the preparation of collodion as that prepared from pure alcohol, but must be free from methyl.

Methylated Spirit. Ordinary spirit mixed with 10 per cent. of wood naphtha.

Methylene. A peculiar liquid hydrocarbon, obtained from pyroxylic spirit.

Methyl-Alcohol. This liquid, known also by the names *wood naphtha* and *pyroxylic spirit*, is one of the volatile products of the destructive distillation of wood. It is very volatile and limpid, with a pungent odor. It is used in photography as a solvent for various purposes.

Methylic Collodion. Gun cotton, or explosive paper, dissolves readily in methylic alcohol, producing a solution of the same general properties as ordinary collodion, and which, like it, may be iodized by the addition of iodide of ammonium. When poured on a glass surface it evaporates, but more slowly, owing to the less volatile nature of the solvent, and leaves a film, which after a short time, or by the application of heat, becomes tough and coherent. The methylic alcohol should be perfectly anhydrous, or the film will be apt to peel off during development on fixing.

Methyl-Orange. (See *Methylaniline.*)

Metol. A developing agent introduced by Hauff, in 1891. According to the maker, metol is the sulphate of methyl-para-amido-meta-cresol. It is a whitish powder, soluble in water; in presence of alkaline sulphites will remain in solution colorless for a long time. Combined with soda or potash, metol forms an energetic developer for gelatine-bromide plates, films, or paper, and for gelatine chloride emulsion papers. The development of negatives with the normal solution is completed in three minutes, and the solution may be used separately until exhausted. With very

short exposures metol yields softer images than pyro or hydroquinone; the soda developer working more slowly than the potash formula, and being therefore more suitable for portraiture. The normal solutions advised by the maker are:

Metol-Soda Developer:

A.	Water	100 parts.
	Sulphite Sodium (cryst.)	10 "
	Metol	1 part.
B.	Water	100 parts.
	Sodium Carbonate (cryst.)	10 "

Mix in equal parts for development; for soft images add more water, or less alkali.

Metol-Potash Developer:

A.	Solution prepared similarly to A in metol-soda developer.	
B.	Water	100 parts.
	Potassium Carbonate	10 "

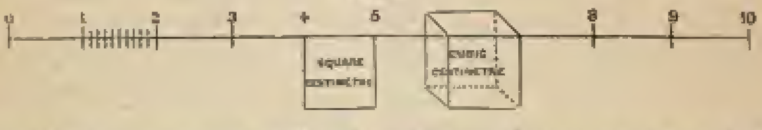
Mix 60 parts of A with 20 parts of B for development. Potassium bromide (solution, 1:10) acts as a restrainer. Another good formula is:

Metol	15 grains.
Sodium Sulphite (cryst.)	90 "
Potassium Carbonate	45 "
Water	2 ounces.

A good method of handling this formula is to start development with the solution minus the carbonate, and when detail is secured, gradually add the carbonate until the desired density is attained. For the development of gelatine aristo papers Liesegang advises a solution of 1 part of metol in 1000 parts of water. This, applied to a faintly-printed aristotype, develops the image in 5 minutes.

Metrical Measuring. The annexed figure shows the length of the centimetre. If we divide one of these into ten parts, each part would be called a *millimetre*; but let us see how this measure of length is applied in obtaining the standard of weight and capacity. If we construct a box which is exactly a decimetre long, wide, and deep, or in other words a cubic decimetre, and fill it with distilled water of a temperature of four degrees Celsius (39.2° Fahrenheit)—this being the temperature of its greatest density—we will obtain the quantity which is designated by the specific name of "litre." The litre is subdivided by 10, 100, and 1000, to which divisions the Latin *deci-*, *centi-*, *milli-*, are prefixed; or multiplied by 10, 100, 1000, when the Greek prefixes *deca-*, *hecto-*, *kilo-*, are used. It is evident that out of such a box, containing a cubic decimetre of water, we would be able to fill a thousand boxes of a capacity of a cubic centimetre each, and the weight of one of these cubes of distilled water of the temperature as stated above is called a "gramme," the multiples of which by 10, 100, or 1000, are called decagrammes, hectogrammes, and kilogrammes, while the divisions receive the names of decigramme, centigramme, and milligramme. It follows, as a matter of course, that the weight of a kilogramme of water (or 1000 grammes) is equal to the weight of a "litre." The above description embraces all that is necessary to know for the special purpose which we have in view—the adoption of this system to photographic purposes.

FIG. 137.

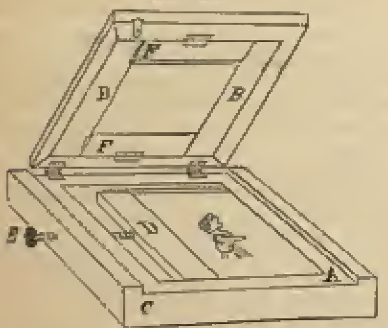


Mezzotint Photographs. Touching up paper prints in light and shade requires care and some knowledge of drawing. The colors to be used must somewhat depend upon the tone of the photograph. Brown madder and India-ink, in the required proportions, will very nearly approximate to the tone of many photographs; whilst others will require these colors with the addition of a little neutral tint, and others a little sepia. The chief point is to use very little color at a time, and in touching the half-tones especially, to work with a tolerably dry brush; you will thus see better the exact depth of the tint you are producing than in working with a pencil fully charged with color. A little Chinese white may sometimes be used, if the photograph be very heavy and wanting in drawing in the shadows, especially in the hair. But it must be remembered that Chinese white is very cold compared with the tone of most photographs, and will require modifying to harmonize. It may also be used for putting the point of light in the eye. Avoid

gum and everything that does not accord with the surface of the print.

Mezzotint, Printing-Frame for. Mr. Forester Clark describes his plan as follows: A is the outside of the frame, made of walnut, 6 inches square and 10 inches thick, but rabetted out ⅜ inch on the sides, to let the cover down flush with the top, and then

FIG. 138.



fastened with a little catch, at C. B B is the cover hinged on to the frame, 6 inches long, but ¼ inch narrower, to let it down into the frame, ⅜ inch thick, and just a piece of board with two strips on the edges to prevent warping. D is a cross-bar that slides in grooves in the frame A, and is to hold the negative with the help of the thumbscrew E. F F are two little pieces 1¼ inches wide and 3 inches long, hinged to the cover to hold the paper, and are made thickest at the outer edge. The operation of the frame is very simple. Fasten your paper on to the cover with the little clamps, which will keep it straight, and fasten your negative with the thumbscrew, putting it back from the paper as far as you choose, and thus you get your picture without "printing through any transparent substance," and also secure much better effects. The idea is to create a small space between the negative and the paper.

Mica. A mineral which can be readily divided into sheets or plates of extreme thickness; transparent, like glass; insoluble in all the chemical products used in photography. It has been suggested as a base for gelatino-bromide emulsion, and plates of mica coated with a sensitive emulsion are obtainable commercially in Europe for photographic purposes. The advantages of mica over glass are found in its thinness, portability, and evenness of surface. Unlike prepared films it will not roll or curl, and mica sheets are not attacked by chemical or atmospheric conditions.

Micro-Photography. The art of producing microscopic pictures of objects. Messrs. Shadbolt and Jackson, of England, reduced this art to practical utility.

Mr. Shadbolt used a thick, short-focus lens to collect the light of the lamp and throw it toward the picture, where, from the convergence of the rays, the light would form rather too small a spot; the lens was therefore interposed so as to spread the light out to cover completely the negative, the latter, for convenience sake, being pressed against a piece of glass by a spring; all in one plane. Now the end of all this arrangement is simply to give us a clearly illuminated picture of about three inches in size, which we proceed to reduce to microscopic dimensions by the microscopic *camera lens*, which is fixed in a table at about the place of the "substage" of the microscope. The camera lens is, of course, of exceedingly short focus, for its ground-glass or collodion-film substitute is placed at the usual place for the principal stage of the ordinary microscope. Wood is here substituted for metal, because it is *here* that the sensitive film has to be placed to receive the image which the ground-glass has assisted us to find. Now let us look at the use of the only part remaining unexplained; the ordinary part of the microscope used to magnify anything properly placed—in this case, our collodion film or ground-glass substitute. Begin by focussing the microscope until the film is distinct; then turn the "fine-adjustment" screw a little to make correction for the chemical focus, the amount being ascertained by experiment. Now leave the microscope with its final corrections as it is, and look through it while, by the camera-lens screw, you throw the image of the negative so that it will be distinct to the eye, as seen on looking in the previously corrected microscope. All is now ready; remove the ground-glass, or its substitute, and put a slip of glass, collodionized on the spot, excited in a little beaker glass full of nitrate of silver (extemporaneously sheltered by placing it in a small plate-box) in the place of the ground-glass, having beforehand covered the lens by a cap placed between it and the negative. Remove the

cap for a few seconds; develop on the spot; wash, fix, and dry as usual.

The principle acted upon is this: that a ray of light refracted by any medium *traverses the same path* whichever end of the said path be made the starting-point. Take, as an illustration, the case of ordinary photographic portraiture. The *sitter* being placed in the *anterior focus* of the lens, the plate is arranged so as to coincide with the posterior focus of the same lens, which latter focus is situated within a much shorter distance from the lens than is the anterior focus. These two foci are termed the *conjugate foci;* and if the sitter were placed in the short focus, an enlarged picture would be produced upon a plate located in the place previously occupied by the sitter. Such an arrangement is adopted whenever an object is placed under a microscope for examination, a picture on an enlarged scale being formed at a comparatively long distance from the object-glass, and this picture is further magnified by the eye-piece. It is from these considerations manifest, too, that if an illuminated negative photograph be made to occupy the ordinary position of the microscopic *picture in the eye-piece*, a greatly reduced image of the same ought to be formed in the anterior focus of the object-glass; and this is found to occur when the trial is made. There are, however, some difficulties to encounter: *First*, it is difficult to ascertain the focus in the case where the five-hundredth part of an inch nearer to or farther from the lens is a matter of moment in placing the sensitive plate. *Secondly*, the lenses of microscopic object-glasses, though as visually correct as possible, have not the visual and chemical focus coincident, a corresponding allowance having to be made when they are used photographically. *Thirdly*, it is necessary to make several trials to ascertain the correct exposure of any given negative—a point of some difficulty, simple as it appears—until the correct allowance for the actinic focus has been determined. A good microscopic object-glass is always *over-corrected* as regards color, that is to say, the blue rays are projected beyond the red. And let it not be forgotten that the most perfectly constructed lens is a thing in which opposite errors are so opposed as to leave only a medium aberration: we cannot have perfection. *Lastly*, if artificial lights be employed for the purpose of illumination, it is necessary that the rays shall fall upon the negative, either parallel or slightly converging, in order that the source of light may be at least as large as the *negative* in appearance. Thus an equality of photogenic action is secured.

"The apparatus is arranged as follows: Having removed the upper stage-plate of a large compound microscope I replace it with one of wood, supplied with guide-pins of silver wire, in order to admit of its supporting a slip of glass coated with collodion and excited in the nitrate bath in the usual way. The microscope is now to be placed in a horizontal position, the objective, intended to produce the picture, made to occupy the place usually filled by the achromatic condenser on the *substage* of the microscope, while *another* objective is screwed into the lower end of the body of the instrument, which is used, not only to focus with, but also to make the necessary allowance for the actinic variation. The negative intended to be reduced is then arranged vertically, with its centre in the axis of the microscopic body, at a distance at from 2 to 4 feet from the lower object-glass, and with a convenient screen of card, wood, or thick paper, to cut off any extraneous light that would otherwise pass beyond the limits of the picture. A small camphene lamp is employed for the purpose of illuminating the negative, having a good bull's-eye lens as a condenser, so arranged with its flat side next the lamp, that the refracted rays shall fill the whole of a double convex lens of about 6 inches in diameter, the latter being placed so as to refract the rays of light in a parallel direction upon the negative. By this arrangement the *bull's-eye* lens of about 2½ inches in diameter *appears* as the source of light instead of the small flame of the lamp. When first I made the attempt to produce these pictures, I *focussed upon the excited collodion itself*, in order that no error might arise from any variation in the planes of the focussing screen and sensitive medium; and to effect this, a piece of deep yellow colored glass was interposed between the lamp and the bull's-eye lens, which was removed for the requisite interval after focussing, to allow of the action of the light to take effect; but subsequently I found that it was possible to focus upon a slip of collodionized glass that had been excited, washed and dried, without removing the iodide of silver, and then replacing it by the slip if intended to receive the impression.

"The manipulation is thus performed: The focussing-glass being placed on the wooden stage with the collodion *from* the observer, the body of the microscope is accurately adjusted so as to focus distinctly the film as seen through the slip of glass, when the exact point is turned so as to focus the object beyond the film, *just so far as the actinic focus of the lens to be employed for producing the picture, differs from its visual one;* the last named lens is then to be carefully adjusted, so that the image of the negative becomes distinctly and sharply defined when viewed through the microscope; and when so seen, the *actinic image* will fall in the exact plane in which the film of collodion is located. The light is then to be shut off, a sensitive film placed instead of the dried one, an exposure of from 10 to 60 seconds allowed, and when removed from the stage the picture is to be developed in the usual way by means of a few drops of the ordinary pyrogallic acid solution. The picture quickly appears as a small dark spot on the glass. It is to be fixed and washed as usual with large pictures, and set aside to dry in a place protected from dust, which last-named substance is, perhaps, the greatest enemy one has to contend with. With regard to the allowance to be made between the visual and actinic foci, there are various methods by which it can be accomplished; but in my opinion by far the best is that afforded by the *fine adjustment* of the microscope itself. If an over-corrected objective, the actinic focus being *more* distant from the lens than the visual one, it is evident that a greater separation between it and the plate is required than for accurate definition by sight; but as the amount of variation probably differs for every individual lens, though nominally of the same power, the exact allowance can only be determined by trial; for a two-thirds of an inch that I generally use with the negative about 4 feet from the lens, the correction required is an elongation of the focus by one-two-hundreth of an inch; while 1½ inch objective of similar make requires an allowance of one-fiftieth of an inch. The proper correction may also be made by withdrawing the negative farther from the lens after focussing. I may also observe that I have noticed a curious fact with reference to allowance for variation in an over-corrected lens, viz., that the amount of it is not the same for daylight as for artificial light. This merits further investigation. It may also be desirable to describe the *developing solution:* 2 grains pyrogallic acid to 1 of citric acid, and 1 ounce of water, is better than an acetic acid mixture, the resulting picture being of a more agreeable tone. The micro-photographs when finished may be mounted by cementing over the collodion a disk of very thin glass by means of Canada balsam."

Microscope. An instrument for viewing magnified images of minute objects invisible to the naked eye. A Mr. Dagron has invented a microscope for exhibiting photographic views. The said invention relates to an improved construction of a dwarf microscope, by which it is adapted for making observations upon microscopic pictures and objects generally, and consists of a peculiar arrangement of the parts of which the instrument is composed, by which it is reduced to so small a compass that it can be attached to a key-ring, pencil-case, or any other portable article or ornament.

Microscope Stereoscope. The lenticular form of the stereoscope is admirably fitted for its application to small and microscopic objects. The first instruments of this kind were constructed by Sir David Brewster, and were 3 inches long and only 1 and 1½ inches deep. They may be carried in the pocket, and exhibit all the properties of the instrument to the greatest advantage. The mode of constructing and using the instrument is precisely the same as in the common stereoscope; but in taking the dissimilar pictures, we must use either a small binocular camera which will give considerably magnified representations of the objects, or we must procure them from the compound microscope.

Microscopic Photographs. Photographs made so small as to be invisible to the naked eye. (See *Micro-Photography.*)

Mignon Paper. A gelatino-chloride of silver paper with matt surface.

Milk. Consists in the main of butter, casein, and sugar of milk. Its serum (the watery part), as also the casein, were considered preservatives in the bath collodion dry process at one time used.

Milk, Serum of. (See *Serum of Milk.*)

Milk, Sugar of. (See *Sugar of Milk.*)

Mineral Tar Oil. Product of the distillation of coal. Is a solvent of asphaltum.

Miniature. A very small portrait, usually painted upon ivory or Bristol board. Mini-

ature photographs are taken upon glass, leather, mica, paper, and other substances.

Minium. Vermilion, red lead, saturnine red, mixture of oxide of lead and brown superoxide of lead; red-yellow powder, used for oil and water colors.

Minimum. The least quantity assignable to a given case.

Minotto's Process for Coloring Photographs. This is sometimes called the "*Grecian method*." It is performed by taking two positive paper proofs precisely alike; one is rendered transparent by means of a varnish, while the other is colored to suit the taste on its face with simple washes of color; when dry they are matched intimately and sealed between two glasses, or between a glass in front and a board behind. The Hallotype (which see) is Minotto's process improved.

Mirror. A polished surface of metal or glass coated on the back with mercury, or other substance, giving it the property of powerfully reflecting light or the image of objects placed before it. Mirrors are used in photography as side reflectors to lighten the shadows which fall upon under portions of the face and figure; for illuminating objects to be copied in the camera by sunlight; and in solar cameras to illuminate the negative with the sun's rays.

Mirror Stereoscope. (See *Reflecting Stereoscope.*)

Mixed Developers. Many varieties of developers are compounded of varying proportions of different developing agents, such as eiko-cum-hydro, a mixture of eikonogen and hydroquinone. It is claimed that these mixed developers combine the good qualities and peculiar characteristics of their ingredients.

Mixtol. A ready-prepared developer, obtainable commercially in Europe. Composed of eikonogen, quinol, sodium sulphite, and a number of caustic and carbonate alkalies in varying proportions.

Modelling. A subject which comes into the practice of photographers every day, the basis of which is formed by the contrast between light and dark. Three methods may be employed for this purpose, all of which differ essentially from one another. These three methods, which are made use of to relieve an object in a picture from its background, are the following:

1. The object is made to appear light upon a dark ground, or dark upon a light ground; that is to say, it is treated as a silhouette. 2. The light parts of an object in the foreground are painted lighter than the ground, while the dark parts are painted darker than the ground; that is to say, the differences in brightness in the object are made greater than those in the ground. 3. The gradations of light and shade in the object are represented as being opposed in direction to the same gradations in the ground; that is to say, the bright side of the object is placed upon a dark ground, the shaded side upon a light ground.

The first of these principles is employed comparatively seldom, for an object treated

FIG. 139.

as a silhouette is apt to look flat, although it is very easy to make it stand out from the ground. The second method may be found in almost every picture, frequently in connection with the third. Every photographer who places a gray background of medium brightness behind the person whose portrait he is about to take makes use of this method. The third principle, however, of which Fig. 139 is an example, is the most effective of all, especially when employed in connection with the second. It was practised most extensively by the great artists of the Netherlands in the seventeenth century. Simple as these various methods of distributing light and shade may appear, it yet required a very long time to bring them gradually to the knowledge of the artists. The second and third, indeed, were already clearly enunciated by Leonardo, but the silhouette proper came into use only at a much later period. Strange as it may seem, however, that the human intellect should have been so slow in discovering such self-evident principles, it is

stranger still and almost inconceivable that these same principles should have been forgotten after they had once become known and had been visibly embodied in the works of the great masters. But this was actually the case at the commencement of the last century, for at that time the comprehension of the principles just mentioned had been lost entirely, while the comprehension of those more subtle aids which may be derived from color was wholly out of the question.

Modify. To change the form or external qualities of a thing; to shape; to give a new form of being; as to *modify* matter, light, or sound.

Molard's Toning Process. M. Humbert de Molard has introduced the following method of toning prints: First fix the print in dilute ammonia; then lay it upon the bottom of a clean dish, and tone it with "iodic cyanide;" then dissolve 10 grains of cyanide of potassium in 100 grains of distilled water, and afterward agitate iodine in this solution until it assumes a violet tint, then add a few particles of cyanide to remove the color. Pour this over the print. It is at first red, but quickly passes to a brown, bistre, black, and gray; after which it becomes effaced if the action is prolonged. As soon as the desired tint is obtained pour water over the print, and wash it thoroughly.

Molecular Impressions. The remarkable relations existing between the physical structure of matter, and its effect upon heat, light, electricity, magnetism, etc., seem, until the present century, to have attracted little attention. Thus, take the two agents, light and electricity: manifestly their effects depend upon the molecular organization of bodies subjected to their influence. Leonard Euler alone conceived that light may be regarded as a movement or undulation of ordinary matter, and Dr. Young, in answer, stated as a most formidable objection, that if this view were correct all bodies should possess the properties of solar phosphorus, or should be thrown into a state of molecular vibration by the impact of light just as a resonant body is thrown into vibration by the impact of sound, and thus give back to the sentient organ an effect similar to that of the original impulse. To the main objection of Dr. Young, that all bodies would have the properties of solar phosphorus if light consisted in the undulation of ordinary matter, it may be answered that so many bodies have this property, and with so great variety in its duration, that *non constat* all may not have it, though for a time so short that the eye cannot detect its duration. This conjecture has been substantially verified by the early experiments of M. Niépce de St. Victor, of which the following is a short *résumé:* An engraving which has been for some time in the dark is exposed to sunlight as to one-half, the other half being covered by an opaque screen; it is then taken into a dark room, the screen removed, and the whole surface placed in close proximity to a sheet of highly sensitive photographic paper: the portion upon which the light has impinged is reproduced upon the photographic paper, while no effect is produced by the portion which had been screened from light; white bodies produce the greatest effect, black little or none, and colors intermediate effects. While fishing at Fontenay, Mr. Grove observed some white patches on the skin of a trout, which he was satisfied had not been there when the fish was taken out of the water. The fish having been rubbing about in some leaves at the foot of a tree gave him the notion that the effect might be photographic, arising from the sunlight having darkened the uncovered, but not the covered portion of the skin. With a fresh fish a serrated leaf was placed on each side, and the fish laid down so that the one side should be exposed, the other sheltered from light; after an hour the fish was examined, and a well-defined image of the leaf was on the upper or exposed side, but none on the under or sheltered side. The number of substances proved to be molecularly affected by light is so rapidly increasing that it is by no means unreasonable to suppose that all bodies are in a greater or less degree changed by its impact. The *electric* discharge alters the constitution of many gases across which it is passed; and it was shown that by passing it through an attenuated atmosphere of the vapor of phosphorus, this element is charged by the electric discharge into its allotropic variety, which is deposited in notable quantity on the sides of the receiver. In this experiment, the transverse bands or striæ discovered by Mr. Grove, in 1852, are very strikingly shown. The glow which is seen on excited electrics, such as glass, is shown to be accompanied by molecular change. Letters cut in paper, and placed between two

well-cleaned sheets of glass, formed then into a Leyden apparatus by sheets of tinfoil on their outer surfaces, and then electrified by connection for a few seconds with a Burkenkorf coil, had invisible images of the letters impressed upon the interior surfaces, which were rendered visible by breathing on them, and at the same time permanently etched by exposure, after electrization, to the vapor of hydrofluoric acid. So, again, if iodized collodion be poured over the surface of glass having the invisible image, and then treated as for a photograph, and exposed to uniform daylight, the invisible image is developed in the collodion film, the invisible molecular change being conveyed to the molecular film, and rendering it, when nitrated, more sensitive to light in the parts where it has been in proximity to the electrical impression than in the residual parts. Here we have a molecular change, produced first by the electricity on the glass, then communicated by the glass to the collodion, then changed in character by light, and all this time invisible, and then rendered visible by the developing chemical agent. Of the practical results to science of the molecular changes a beautiful illustration was afforded by Mr. De la Rue's photographs of the moon, which afforded, by the aid of the electric lamp, images of the moon, of six feet diameter, in which the details of the moon's surface were well defined. The ever-increasing number of instances of molecular changes afford a boundless field of promise for future investigation for new physical discoveries and new practical applications.

Molecule. A name given to the very minute particles of which bodies are supposed to be composed, but not so small as the atom, which is the ultimate particle.

Monckhoven's Developing Process. In this process sulphate of uranium is employed in the same manner as pyrogallic acid, but requiring a shorter exposure than when sulphate of iron is used. The pictures acquire extraordinary vigor; the development at first proceeds very slowly, but suddenly becomes very rapid, and when complete, its further progress must be stopped by immersing the collodion plate in water.

Moniconostereoscopic Glasses. This invention, patented by Mr. T. Wharton Jones, consists of optical glasses giving a stereoscopic effect to single pictures of any kind viewed through them with both eyes. The glasses have a plane surface on one side; on the other side the surface is concave, with a curvature such as would be formed by a straight line which moves parallel to itself, guided by a parabolical curve. There is a superaddition to the glasses as now described, of a convex or concave power, according as the person using them is far-sighted or near-sighted. It is essential that the glasses be so set in the frame that the straight line which, by moving parallel to itself, forms the cylindro-parabolic surface be perfectly vertical when the glasses are held before the eyes. It is also essential that the glasses be so set in the frame that their similar portions, as regards the concavity, be towards and from each other.

Monochromatic Lamp. A lamp fed with a mixture of a solution of common salt and spirit of wine. It gives a yellow light, and makes every object illuminated by it appear either yellow or black.

Monochrome. An ancient mode of painting in which only one color is used. The most numerous monuments of this kind of painting are on terra-cotta.

Monocular. Having but one eye.

Monocular Camera. A camera with a single lens; principally used in taking views of landscapes and still life.

Monocular Vision. Seeing with but one eye.

Moonlight Effect. Landscapes exposed by daylight but with moonlight effect. To accomplish this the exposure is made toward the sun (when in a cloud); it must be short and with the smallest stop, developed slowly with old or diluted developer, the action of which must be interrupted before the half-tones become strong. The result is a harsh light-effect, exceedingly rich in contrasts.

Moonlight Photographs. Photographs of out-door scenes may be obtained at night by moonlight by sufficiently protracted exposures. Generally, however, photographs showing moonlight effects are secured by photographing the scene with the setting sun in front of the camera, but obscured by clouds. Preferably a day should be chosen when the sky is full and broken up by well-defined cloud masses. This gives brilliant lighting with dense masses of shadow.

Mordant. A species of substances used in dyeing for binding the coloring matter to the material to be dyed, so that washing, etc., cannot remove it. The mordant mostly used

in photography is bichromate of potash, because light disintegrates it. (See *Photography on Fabrics*.)

Mordant Washes. Solutions of mordant substances used in photography for the preparation of sensitive papers.

Mortar. Round porcelain, glass, or agate dish, rather shallow, for pulverizing solid bodies with a pestle.

Mortuary Photographs. Photographic copies of mortuary memorials; inscriptions on tombstones, church tablets, etc.

Mosstype. An American modification of the process (Meissenbach) for producing half-tone photo-engravings, devised by the late John Calvin Moss, of New York. The pictures by the Mosstype process are remarkable for the brilliancy and purity of the high lights.

Mother-Lye. Lye; ley; a liquid from which crystals have formed or separated.

Motion Photographs. Carl Anschütz and others have devoted considerable effort to the photography of animals in action. For this purpose they employ a battery of lenses mounted upon a camera of peculiar construction, obtaining thereby a number of studies showing the various motions made by animals in action.

Mountant. Any substance used to make a photograph adhere to a mount or card is so called. Those most commonly used are gum or paste mucilages, such as starch-paste, arrowroot, gum, dextrin, India-rubber solution, liquid glue, and animal and vegetable gelatines.

Mounting. In photography, the pasting of photographic prints upon cardboard or other material.

Mounting Commercial Work. Mr. S. V. Courtney employs the following method with complete success:

Immerse the albumen paper for fifteen minutes in a solution of alcohol, 3 parts; water, 1 part; to which has been added a small quantity of spirits of camphor. The paper is then drained and dried between blotters. The alcohol solution can be used again and again. When ready for mounting, place both prints and albumen paper in the following solution:

Alcohol	1 ounce.
Glycerine	1 "
Water	4 ounces.

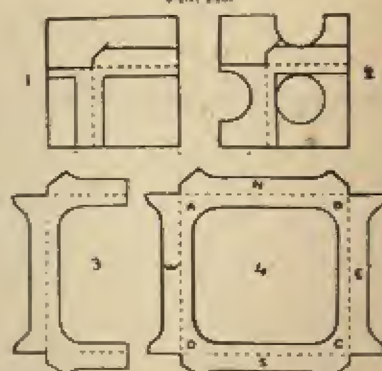
until they are well saturated with the solution; they are then placed for mounting, face down, the albumen paper in one stack, the prints in another; they are then squeezed to remove the surplus solution, and stood up to drain. The prints are then pasted and laid on the back of the sheets of albumen paper and well rubbed down; be careful to exclude all air from between the prints and the albumen paper. They are then laid out to dry on clean cloth or blotters.

When about dry they will be found to be somewhat wrinkled and curled. Now place them one on top of the other and weighted down, to remain for about half an hour, or until ready for burnishing—when they have *sweated* out flat and are in good condition for the burnisher.

Mounting Microscopic Photographs. Mr. Wentworth L. Scott has devised a very ingenious plan of mounting microscopic objects. He employs as cells very thin disks of pure gutta-percha, with apertures cut in the centre of each the size of the interior of the cell required. The way to employ them is to warm the clean side, lay the cell in the middle and dab it down with one finger all around, taking care not to soil the inner portion of glass. When cool, place the object on and cover it with thin glass the same size as the cell, warm it again and press firmly down with a cloth. Trim the edges if needed, and gum on each side of the slide a piece of paper a little larger than the cell and label. The same method may be applied to microscopic glass positives.

Mounting Lantern Slides. Both *faces* of the slide are similarly masked. The form of

Fig. 140.



1. Folded and marked. 2. Punched. 3. Trimmed. 4. Opened and finished.

paper to effect this for the commonest shape of opening is shown by 4. This, after the face has been well pasted, is placed on a loose piece of flannel; the transparency, with covering glass tacked on with thin layers of sealing-wax inside the corners, is then imposed face downward upon the mount, and brought to coincide with the square A B C D. The sides marked W and E are then turned over upon it by lifting the edges of the flannel, one after the other, and the operation is finished by next turning over the sides N and S. Matts and binding strips are also supplied in the trade.

Mounting Photographs. This is a very simple process, yet requiring care. The adhesive substance may be made of gum-arabic in solution, or dextrin, or starch made into paste over a gentle heat. The two latter are perhaps the best on many accounts. The cardboard and pictures are cut to the required size; the picture is laid face downward upon a clean board, or plate glass, of the same size, and the gum or paste applied with a brush until the paper lies perfectly flat and humid and the paste is smooth and free from specks or particles. The gum or paste should not be so thin as to run over the edge of the paper, nor so thick as to spread with difficulty.

Mounting Stereographs. In mounting stereographs something more is required than merely sticking them to a piece of cardboard at an arbitrary distance apart. When the prints are properly mounted and viewed through a properly constructed stereoscope, the effect of natural size and distance is realized; but when the prints are imperfectly mounted and viewed through an imperfectly constructed stereoscope, the effect of natural size and distance is not realized; but in place of it the objects appear to be of a very diminutive size, and to be situated at a very short distance from the spectator. The proper mode of mounting stereographs is first to separate the pair of pictures and trim the edges of each print. It is necessary to separate the pictures and reverse them; if this were not done the picture from the left station would be presented to the right eye in the stereoscope, and conversely, which would produce a pseudoscopic effect. Then trim them 3 inches high and 2½ inches wide, and mount them so that the central points of the pictures (that is, where the axis of the camera cuts them) are 2½ inches apart, and consequently, exactly opposite to the centres of the twin lenses of the stereoscope. By this method, when the lenses of the stereoscope are of the same focal length as those of the camera, the true natural effect of size and distance is perceived on looking at the prints through the stereoscope. This plan involves the necessity of reducing the breadth of the prints, and therefore of cutting out some of the objects. This cannot be helped, but if it is of importance to retain them, then lenses of shorter focus must be used, both in the camera and in the stereoscope. Stereographs upon thin albumenized paper may be mounted so as to be viewed by transmitted light; and then by applying color to the back of the print where it is required, and laying a piece of tinted tissue paper on the back, very pleasing effects may be produced.

Mucilage. One of the proximate elements of vegetables. The same substance is a gum when hardened, and mucilage when in solution. Solution of gum-arabic is an example. The liquor which moistens and lubricates the ligaments and cartilages of the articulations or joints in animal bodies.

Muller's Self-developing Process. (See *Self-developing Negative Process.*)

Multiple Films. In order to avoid the danger of halation in photographing interiors with windows, or foliage against a bright sky, plates have been introduced commercially, coated with several films of emulsion differing from each other in sensitiveness. These are known as multiple-coated plates.

Multiplying Camera. An arrangement usually at the back of the camera, consisting of a number of frames in the same plane, and movable into each other, for the purpose of taking a number of pictures in succession on one and the same plate.

Multiplying Device. An invention of D. W. S. Rawson for multiplying pictures. The images are obtained by a series of small adjustable mirrors arranged to receive the image alike, and all of which are photographed at one time by the camera. The invention was intended to overreach the patent for the sliding plate-holder camera.

Muriate. A compound formed by the union of muriatic acid with a base.

Muriate of Ammonia. (See *Hydrochlorate of Ammonia.*)

Muriate of Baryta. Composed of 1 part of baryta, 1 part of muriatic acid, and 1 part of water.

Muriate of Cobalt. Composed of 1 part oxide of cobalt, 1 part of muriatic acid, and 1 part of water.

Muriate of Copper. A union of muriatic acid and copper in equal parts. We may always depend upon producing a photographic copy of a leaf of a green color by the following arrangement: Take a silvered copper plate, place it in a shallow vessel, and lay thereon a leaf of which a copy is desired, maintaining it in its position by means of a piece of glass; pour upon it, so that the plate beneath the glass may be covered, a solution of the hydriodate of potash containing a little free iodide; then expose the whole to sunshine. In about half an hour one of the most beautiful photographic designs which can be conceived is produced, of a fine green color.

The fluid is yellow and cuts off nearly all the chemical rays, allowing only of the free passage of the less refrangible rays; the most abundant being the yellow. This retards the process of solarization, but it produces its complementary color on the plate. (See also *Hydriodic Salts*.)

Muriate of Iron, Proto-muriate of Iron. This salt is prepared by pouring dilute muriatic acid on iron wire or clean iron filings. This salt gives photographic pictures, but not of practical utility.

Muriate of Lime. This salt is readily prepared by saturating muriatic acid with pure marble. It is a very deliquescent salt, soluble in alcohol and water, crystallizing with difficulty in prisms. These crystals, when united with snow, produce a very intense degree of cold. The muriate of lime gives photographic papers, not particularly sensitive, deepening to a brick red in full sunshine, but is less liable to change in the fixing solution than almost any other preparation. (See *Mordant Washes*.)

Muriate of Soda. Common salt. This important compound is diffused throughout Nature, the most common and principal part being made by the evaporation of saline water. (See *Mordant Washes*.)

Muriate of Strontia. This is prepared in the same manner as muriate of baryta. It forms prismatic crystals, soluble in alcohol, giving to flame, when burning, a red tinge. (See *Mordant Washes*.)

Muriate of Tin. Chloride of tin. There are three muriates of tin—*proto-muriate*, *per-muriate*, and *sub-muriate*.

Muriated Paper. Photographic paper prepared with solutions of the muriates. (See *Mordant Washes*.)

Muriatic Acid. An acid gas consisting of chlorine and hydrogen.

Myricin. That portion of beeswax which is insoluble in alcohol.

N.

Naphtha. A compound of 6 parts carbon with 6 parts of hydrogen. It exists native in many parts of the world, under the name of mineral naphtha, rock oil, and petroleum. It may be obtained by distillation from coal-tar, and may be purified by re-distillation, mixed with a little sulphuric acid. It is liquid at common temperatures; requires nine parts of oxygen for its combustion, and unites with ether, alcohol, and oils. It has an unpleasant odor, dissolves caoutchouc and gutta-percha, but does not combine with water. It is used in the daguerrean process, in combination with sulphuric ether, to clean the plate.

Naphthalin. A white, crystallizable, odorous, volatile substance, obtained by redistilling coal-tar. It melts at 180° F., is soluble in alcohol and ether, and forms with sulphuric acid *sulpho-naphthalic acid*.

Naphthalene-Blue. Indophenol-blue. Suggested as a sensitizer, in connection with malachite-green, for orthochromatic photography, in place of azaline.

Nascent. The *moment* of birth or individual existence. In chemistry, the *instant* one substance is set free from another.

Nascent State. To act upon a body in its nascent state is to employ it at the very moment of its formation, before the air or any foreign substance has had time to modify it.

Natural-Color Photography. Since the earliest days of photography, efforts have been continuously made to photograph objects and obtain them in their natural colors. It would be impossible to detail here the course and results of these experiments. The problem seems to have been attacked from every possible point of vantage, but photography in natural colors, as generally understood, *i. e.*, the obtaining of negatives or positives direct which show their subjects in colors, has not yet been accomplished. Passing over the work of all except the latest experimenters,

we may record the facts that in 1891-92, Professor Lippmann claimed to have obtained upon a collodion plate a photograph of the spectrum, showing the colors true to nature. Prof. Lippmann has been followed by Lumière Bros. F. E. Ives, after devoting many years to the study of the subject, has produced a heliographic system, consisting of a triple transparency which, viewed in an instrument of peculiar construction, called a heliochromoscope, gives the subject as photographed in the colors of Nature. Ives' efforts are said to mark the highest achievement in this direction thus far accomplished. R. D. Gray has also succeeded in producing by chemical and optical means pictures which, projected upon a screen, present the subject in colors approximating those of Nature. Other workers have also contributed valuable and interesting results; for details refer to the photographic journals of the past ten years.

Natural Colors, Photography in. (See *Heliochromy*, etc.)

Natural Printing. (See *Photography.*)

Naturalistic Photography. 1. A name given to the work of a class of photographers who seek to produce by photographic methods the results obtained by painters of the "impressionist" school. Naturalistic photographs, therefore, are characterized by fuzziness of outline and diffusion of focus, and are only sharp in one plane, according to the naturalistic theory "that a picture should be as sharp as the eye sees it, and no sharper." This school has many followers in England, but does not seem to be regarded with favor by American workers.

2. *Naturalistic Photography.* A process for taking direct life-size portraits by flash-light. So called because true to Nature in results.

Nebular Photography. Photographing the nebulæ, such as are found in the milky way, etc. (See *Astronomical Photography.*)

Negative. A picture obtained by exposure in the camera and subsequent development, in which the lights of the model are black and the blacks white, right and left being reversed. From this negative a positive can be obtained in a printing-frame or camera. (See *Positive.*)

Negative, Albumen. The use of albumen as a film upon glass for negatives, originating in the desire to obtain a more even surface-layer of iodide of silver than the coarse structure of the tissue of paper will allow, was the simultaneous discovery of M. Niépce de St. Victor, of France, and Mr. J. A. Whipple, of Boston, Mass. The process is conducted with simple albumen or "white of egg," diluted with a convenient quantity of water. In this glutinous liquid iodide of potassium is dissolved, and the solution, having been thoroughly shaken, is set aside, the upper portion being drawn off for use. The glasses are coated with the iodized albumen and then dried. This part of the process is considered the most troublesome, the moist albumen easily attracting particles of dust, and being apt to blister and separate from the glass. If an even layer of the dried and iodized material can be obtained, the chief difficulty of the process has been overcome. The plates are rendered sensitive by immersion in a nitrate of silver bath; are then washed in water and dried, and may be kept for a long time in this state. The exposure in the camera must be unusually long; the free nitrate of silver having been removed by washing, and the albumen exercising a direct retarding influence upon the sensitiveness of the iodide of silver. The development is conducted in the ordinary way with pyrogallic acid. It usually requires one hour or more, but may be accelerated by the application of heat. Albumen negatives are remarkable for elaborate distinctness in the shadows and minor details, but they do not often possess the peculiar and characteristic softness of those upon collodion. The process is well adapted for hot climates, being very little prone to the cloudiness and irregular reduction of silver, which are so often complained of with moist collodion under such circumstances. (See *Albumen Process.*)

Negative Albumen Process. Coat the plate with any kind of collodion, iodized or un-iodized; wash well in ordinary water, drain, and pour on the albumen prepared with

Iodide of Potassium	4 to 6	grains.
Bromide of Potassium	1 to 1½	"
Water	2	drachms.

Use the albumen as in the Fothergill process—first quantity, to drive off the water; second quantity, work well over the plate, and then drain it well and rear it up on one corner in a warm oven or over the gas to dry. *Excite* in a bath of

Nitrate of Silver	60	grains.
Acetic Acid	60	minims.
Water	1	ounce.

Wash thoroughly—you cannot wash it too much—and rear up to dry in the dark. It can now be kept for hours, days, or months, till required. *Expose* about double the time of wet collodion—say landscape lens, 15 inches focus, full sunshine, about 2 to 5 minutes. *Develop* with a saturated solution gallic acid, and a few drops of a 50-grain solution nitrate of silver. By varying the quantity of nitrate any kind of tone can be got. A small quantity gives brown; more, black tones. Wash, fix, and wash again. The advantages claimed for this process are, that it possesses the peculiar beauties of plain albumen, without any of its necessary difficulties of preparation; the collodion coating enables you to pour on the albumen without trouble, and to dry immediately without drying long or fear of dust. It keeps admirably; it works much quicker than plain albumen, and beautifully clear; it can be developed as soon as taken, or deferred until next week or month, and when fixed and washed is as firm as any varnished picture can be, and so adhesive that you can hardly tell which side of the glass it is on.

Negative, Collodion. Collodion as a film for negatives was first recommended by M. Le Gray, but first applied by Mr. Scott Archer, and from its ease of application and other good qualities, it long took precedence of all other substances. The processes for using collodion are similar to those for albumen, but they present many more difficulties, although these difficulties are more readily overcome than those of the albumen process. A collodion containing a very small proportion of iodide, and yielding a blue transparent film in the nitrate bath, is not well adapted for negatives. Pale opalescent films often give too little intensity in the high lights, and, unless, the nitrate bath be acid, do not admit of being exposed in the camera for the proper length of time without cloudiness and indistinctness of image, being produced under the action of the developer. The effect known as "solarization of negatives" is also more liable to occur. On the other hand, if the layer of iodide be too yellow and creamy, the half-tones of the image will often be imperfectly developed, so that a middle point between these extremes is the best. A pure and newly prepared collodion, although highly sensitive to light, does not always give, with one application of the developer, a sufficiently vigorous image to serve as a negative matrix, and this particularly in the most brightly illuminated parts. But on keeping the collodion for some weeks, it becomes yellow, if iodized with alkaline iodides, and a decomposition takes place in it, which lessens the rapidity of action, but adds to the intensity of the negative. Grape sugar or glycyrrhizin may be employed to give intensity to newly mixed collodion; but, as they have the effect of lessening its sensitiveness and keeping qualities, they should be used cautiously. In taking portraits in the open air on bright days, and with a bath which has been mixed for a considerable time, it will be rarely found that the intensity will be deficient, and especially so if the developer be applied a second time to the film with a few drops of solution of nitrate of silver added. In landscape photography, however, or in copying engravings, where extreme sensitiveness is not an object, the glycyrrhizin may sometimes be added with advantage, in order to obtain perfect opacity of the blacks. When the use of this substance is resorted to, the mode of iodizing the collodion appears to be of importance, the increase of intensity being greater with the iodide of cadmium than with the iodides of the alkalies; the latter probably exercising a decomposing action. An addition of a bromide or a chloride to the collodion, in small quantity, has also a marked effect in adding to the intensity when glycyrrhizin is used with alkaline iodides. Substances which produce intensity of the collodion image have often, if added in too large quantity, a tendency to lower the half-tones, and prevent the darker parts of the picture from being sufficiently brought out. The print from the negative is then pale and white or "chalky," as it is termed, in the high lights. Collodion in this condition is often preferred by the beginner, from the facility with which negatives are obtained, but it does not give the finest results. An excess of glycyrrhizin in collodion has also the effect of intensifying with the precipitation of the iodide of silver, producing a blue and murky film which is useless for negatives. A judicious employment of free iodine in collodion which has been previously intensified with glycyrrhizin has a remarkable effect in improving the gradation of tone. The excessive opacity of the high lights is diminished, and hence the

operator is enabled by a longer exposure of the sensitive plate to bring out the shadows and minor details of the image with great distinctness. Collodion prepared in this manner is too slow for portraits, excepting in a strong light, but often gives an image having great roundness and stereoscopic effect. The iodine and liquorice sugar, employed conjointly, tend also to preserve the clearness of the plates, the influence of the developer, and to give sharpness to the lines and dots of engravings, etc., which, with a new and sensitive collodion, are often imperfectly rendered. These advantages will be appreciated by the operator who has failed from working with a too feeble collodion; but it must be borne in mind that all substances acting as intensifiers *in the collodion* have a bad effect when the state of the film is not such as to call for their employment. The photo-iodide of iron has been recommended as an addition to negative collodion, but it is not stable. (Consult INDEX.)

Negative Bath. A solution of nitrate of silver, in which wet collodion plates are sensitized.

Negative-Lifter. To prevent contamination by contact with the fingers in many photographic processes, it is necessary to lift the plates from the solutions by some

FIG. 141.

mechanical means. The method shown in the figure will be found available and is easily understood. The lifter or tongue should be made of silver wire, although it may be made of any other material that will not contaminate.

Negative Paper. Paper prepared for the reception of *negative proofs*. There are several methods for preparing this paper, some of which are the following:

Preparation of Negative Paper with the Iodide of Potassium. In a large, flat dish in which the paper is prepared, pour a saturated solution of iodide of potassium. Plunge the paper into this solution, and let it soak from one to two minutes, according to its thickness; after which take it by the corners and withdraw it from the bath; pass it twice successively, and without letting it slip from your grasp, into a very large vessel filled with distilled water, or, in its stead, with rain water; then press it between several sheets of blotting-paper, until it is perfectly dry. Submit it then to the aceto-nitrate, and to exposure, and proceed after as explained in other parts of this work. The preparation furnishes a very fine proof; its execution, as we see, being extremely easy, and almost absolutely certain. It is preferable to prepare the paper at the moment of executing the proof; the effect is more constant and certain. The passing of the iodized paper into the bath of distilled water has the effect of carrying off the iodine which remains at the surface of the paper. The paper, therefore, must be well dried, and dried outwardly, so to speak, by means of the blotting-paper, before it is submitted to the aceto-nitrate of silver, without which the image will not be clear. All these manipulations may be carried on in broad daylight; the paper, rendered very dry, is put together into a pasteboard case, and it will preserve its chemical properties for months.

Preparation of Negative Paper with Serum. Into one and a half ounces of serum of milk, which is strained through fine linen to separate the casein, stir the white of an egg; after depriving it of all solid matter boil it; then strain it again through a paper filter, after which, upon cooling, dissolve in it 3 per cent. of its weight of iodide of potassium. To use this liquid proceed in the following manner: Plunge the paper which is to undergo the preparation, into the liquid, in which let it remain for two minutes, and when it is very uniformly impregnated, dry by suspending it with two pins to a piece of tape which is placed horizontally. This preparation is conducted in daylight, without any particular precaution; the paper can be used in the most flexible state; we then dry it with the blotting-paper before submitting it to the aceto-nitrate. If it is intended for subsequent operations it should be left to dry completely. Protected from

moisture and dust, this paper keeps almost indefinitely.

Preparation of Negative Paper with Albumen. Beat the albumen of eggs into foam into which, for each white of egg, add 30 drops of saturated solution of iodide of potassium (in weight, 30.8 grains), and 2 drops of a saturated solution of bromide of potassium. We increase the sensitiveness of the albuminous paper by diminishing the proportion of iodide and omitting the bromide; thus we can descend to 10 drops of iodide to the white of an egg; the vigor of the effects to be produced decreases according to the diminution of the chemical element in the preparation. We let it remain until the foam returns to the liquid albumen; if we do not find this liquid perfectly clear, we filter it. We can prepare this compound in many ways. It may be covered upon one of its surfaces only with this iodized albumen, without which there may be differences of thickness in the coating, with bubbles of air upon its surface. If we make use of paper too fine we insure an easy preparation, by giving the sheets of paper a larger extent than the proof which it is intended to obtain; we then bend the four edges at right angles and confine them by pasting with glue or sealing-wax. The paper consequently presents the form of a tray. We lay it upon a glass to obtain a perfectly horizontal surface, and then pour in the albumen. In order to guard against the formation of air-bubbles, we introduce a tablespoonful at a time of the albumen; we commence at one of the corners and spread the albumen in the desired quantity toward the opposite corners; after which, elevating the glass upon which the paper is placed, we give every side, alternately, a sufficient inclination to convey the albumen over the whole interior surface; then, pouring out the excess, we pull down the raised edges and hang up the paper by two pins to a piece of tape fastened horizontally, in the same manner as was remarked for the preceding preparations. It is not necessary to collect the paper until perfectly dry, which may be completed by holding it before a hot fire, or by ironing it with a very hot iron between several sheets of white paper, perfectly clean, which latter mode will be preferable, because it will better insure smoothness. This paper will keep well a long time.

Preparation of Negative Paper with Bromide of Iodine. All liquids termed accelerative, used in photography on silvered plates, having for their base iodine in combination with chlorine or bromine, will answer for preparing photographic paper. The preparation of the papers by these substances is not susceptible of general application; first, because they do not give a superior result to that obtained by the preparations with iodide of potassium; secondly, on account of the disagreeable odor which they evolve in the course of the manipulations; and finally, because papers impregnated with chloride or bromide of iodine require to be used immediately after their preparation. At the end of a day, sometimes of an hour—the chemical elements may be volatilized, and the papers lose all their photographic properties.

Preparations of Negative Paper with Gelatine. Dissolve in 1¼ pints of hot distilled water, 385 grains of isinglass of commerce.

Take of this sizing, still hot, 11¾ ounces. Add

Iodide of Potassium . . .	200	grains.
Bromide of Potassium . .	61	"
Chloride of Sodium . . .	30½	"

Let the mixture dissolve well, and then filter through a fine linen cloth. Put this solution, yet hot, into a large dish, into which plunge your paper completely, sheet by sheet, one upon the other, taking good care to disperse the air-bubbles that might be formed. Leave the paper a quarter of an hour in this bath; then hang it up to dry. This is the original method of adapting gelatine to the manufacture of printing-out papers. It is now obsolete. (See *Aristotype*, *Bromide*, etc.)

Alcoholic Preparations for Negative Paper. I obtain moreover a very good negative paper with the following alcoholic solutions:

No. 1.	Pure Alcohol at 36° .	1000	grains.
	Collodion	10	"
	Iodide of Potassium .	10	"
	Cyanide of Potassium .	1	"
No. 2.	Alcohol at 36° . . .	1000	"
	Camphor	15	"
	Lac Varnish (alcoholic) .	6	"
	Iodide of Potassium .	8	"
	Cyanide of Potassium .	2	"
	Fluoride of Potassium .	2	"

The advantage which these preparations offer is that of permitting us to soak a great quantity of sheets at once, the alcohol penetrating them with the greatest facility. When you have chosen one of these formulas pulverize the salts and resins, and

then put them with the alcohol in the bottles, leaving them a day or two before using. Be careful during the interval to shake them occasionally, to facilitate the solution. At the expiration of this time, should any matter remain undissolved, it need give you no uneasiness; pour the liquid into a basin, filtering it through brown paper to clear it. Then soak all the paper in the basin, covering it over with a glass to prevent evaporation of the alcohol, and make the latter penetrate everywhere between the sheets. After a quarter of an hour withdraw them *en masse*, drop them at once into the basin and pierce them at the same time with a silver needle in order to string them on a pack-thread, which you attach to the walls from one side of the room to the other. Separate each sheet by sliding them along the pack-thread, and you will find that you can prepare and dry a large number of sheets in a little time. This paper may be preserved extremely good a long time. *The silver solution* for these papers may be prepared with

Nitrate of Silver	7 grains.
Acetic Acid	10 "
Distilled Water	100 "

Float the sheet on this for about one minute, then by means of a glass rod sink it under, withdrawing it in about five minutes; then wash and sponge it and leave it to dry between sheets of blotting-paper. One very important thing must be observed: that is the non-employment of a bath which has become discolored with animal-black. The discoloration should be removed with common pipe-clay.—*H. H. Snelling.*

2. *Negative Paper.* Paper coated with gelatine bromide of silver emulsion, on which direct exposures may be made in the camera. Before printing these papers are made transparent by oil, fat, etc.

Negative Picture. The image of an object developed and fixed upon albumen, collodion, or other film or prepared surface. (See *Negative.*)

Negative Proof. (See *Negative* and *Negative Picture.*)

Negative Solutions. The various solutions employed in the negative processes. They consist of the collodion, nitrate of silver bath, the developing fluid, the hyposulphite of soda solution, and the various washes for iodizing paper for negatives.

Negative Varnish. Every negative intended to be used as a printing matrix should be varnished. There are quite a number of varnishes employed for this purpose, described in this work, for which see *Amber Varnish*, *Benzoin Varnish*, *Dammar Varnish*, *Maddison's Varnish*, etc., and *Varnish*. Gum shellac dissolved to the proper consistency in alcohol makes an excellent negative varnish. For the method of applying varnishes to the negative, see *Varnishing the Negative; Varnish*, etc.

Neomoscope. An instrument invented by M. Bean for viewing photographs or other similar pictures. It consists of a cone-shaped case, with a part of one of the sides removed to admit light, fitted with a flap or not, as desired. The lens or lenses are fitted in the top of the apparatus, and, in some cases, flaps for forming, when raised, a dark chamber round the eye and glasses, are added. The bottom of the apparatus is made to slide, to admit of its being entirely removed in order to view transparent objects or others apart from the apparatus itself. The sides are either made rigid or to fold. The inventor sometimes adds a pocket, which forms a part of the sides or bottom of the apparatus, to contain photographic or other representations.

Neutral. Inert. The term is applied when the peculiar nature of a compound or substance is rendered imperceptible.

Neutralize. To destroy or render inert or imperceptible the peculiar properties of a body, by combining it with a different substance.

Neutralization of the Silver Bath. The silver bath frequently becomes too acid by use or accident, and requires neutralizing. To effect this, remove the solution to a wide-mouth jar from 6 to 8 times the capacity of the bath. It is necessary to have the jar sufficiently large to avoid overflowing by the effervescence of the liquid. Drop into the solution, cautiously, bicarbonate of soda as long as effervescence continues and until all the silver is precipitated as a carbonate, stirring continually with a glass rod. Let it stand a few minutes, then pour off the clear liquid; wash the precipitate in four or five waters, and redissolve it with pure nitric acid, and fill up to nearly the original capacity with pure water. If the solution now proves alkaline to test paper, add glacial acetic acid, drop by drop, until completely

neutralized, or the required acidity is attained. Filter and return to your bath. *Another method* is to saturate the solution with oxide of silver, let it stand for a short time, or over night, and then filter. Some photographers use the caustic alkalies as preferable to carbonate of soda or oxide of silver. Aqua ammoniæ may be used to effect the neutralization, by adding it drop by drop until the desired effect is produced, and afterward filtering.

Neutralizing. Counteracting the acid reaction of a solution by the addition of an alkali till they balance each other, or till test-paper no longer changes its color in the mixture.

Neutral Salt. A salt composed of an equal number of equivalents, both of acid and base; a salt in which none of the properties of the acid or base are perceptible.

Newton's Printing Process. This an obsolete process effected by development, due to Mr. H. J. Newton.

Night, Photography at. (See *Artificial Lighting.*)

Nitrate. A salt formed by the union of nitric acid with a base.

Nitrate Bath. A term applied to the solution of silver in which the iodized film, or paper, is immersed to acquire sensitiveness to light. There are five kinds of nitrate baths, viz., the *negative*, the *positive*, the *aceto-nitrate for plain paper*, the *ammonio-nitrate*, also for plain paper, and the *plain nitrate bath* for albumenized paper. The three latter are more generally known as *nitrate solution*. (See *Nitrate Solution.*) The *negative nitrate bath* should be prepared from the purest nitrate of silver which has been melted (much of that sold to photographers is adulterated). If this point is neglected the best collodion will fail in producing an intense negative. Acetic acid must be added in minute quantity to preserve the solution from a too ready reduction by the alcohol and ether of the collodion. Also, unless the nitrate of silver be quite pure and free from organic matter, clear pictures will not be obtained without the use of acid. Acetate of silver has often been advised as an addition to the negative nitrate bath. It is produced by dropping into the solution an alkali, such as ammonia, followed by acetic acid in excess. The negatives are rendered blacker and more vigorous by this proceeding, but especially so when the bath is contaminated with nitric acid, which neutralizes itself at the expense of the acetate of silver, thus:

Acetate of Silver + Nitric Acid
= Nitrate of Silver + Acetic Acid.

As a rule, it will be better to avoid adding acetate of silver to the bath, since with pure melted nitrate of silver no nitric acid can be present, and perfect intensity can be obtained. When the bath is saturated with acetate of silver, it is in a more reducible state, and hence, unless the glass plates are very perfectly cleaned, black lines and markings, the result of irregular action, will be produced on the application of the developer. *Solarization*, or reddening by over-exposure, is also promoted by the presence of acetate of silver. The formulæ for negative baths are various, and may be found under the various albumen, collodion and paper processes described in this work. Mr. Hardwich's formula is as follows:

Nitrate of Silver . . .	30 grains.
Glacial Acetic Acid . . .	½ minim.
Alcohol	15 minims.
Distilled Water	1 fluidounce.

The bath must be saturated with iodide of silver, and nitric acid neutralized if present.

The Positive Nitrate Bath. If the materials are pure, the negative bath may be diluted down at the same time with the collodion, when positives are to be taken; but the employment of a very weak bath, although highly useful in obviating excess of development, has some disadvantages; it becomes necessary to exclude free nitric acid, and to avoid the employment of a collodion too highly treated with iodine. On the other hand, with a strong nitrate bath, and a tolerably dense film of iodide of silver, a better result is often secured by the use of nitric acid. The sensitiveness of the plates is impaired, but at the same time intensity is diminished, and the picture shows well upon the surface of the glass. A new bath is better for taking positives than one that has been a long time in use. The latter often causes *haziness* and irregular markings on the film during the action of the developer. This is due partly to the accumulation of alcohol and ether in the bath, which causes the solution of sulphate of iron to flow in an oily manner, and partly to the reduction of the nitrate of silver by organic matter. The presence of acetate of silver is objectionable in the positive bath as producing solarization

and intensity of image; hence the precautions which obviate its formation must be adopted. Acetate of silver is not formed by the simple addition of acetic acid to the bath, because its production under such circumstances would imply the liberation of nitric acid; but if an alkali be present to neutralize the nitric acid, then the double decomposition takes place, thus:

Acetate of Ammonia + Nitrate of Silver
= Acetate of Silver + Nitrate of Ammonia.

Acetate of silver is a white flaky salt, sparingly soluble in water, but yet sufficiently to affect the photographic properties of the film. (See *Neutralization of the Nitrate Bath.*) If fused nitrate of silver be used for the positive bath, it is very important that the fusion should not be carried too far, or the solution will contain a basic nitrate of silver, and yield an intense, solarized, and misty image. The positive nitrate bath may be made by the same method given above for the negative bath, substituting one-twentieth of a minim of nitric acid for the acetic acid. For other formulæ see *Ambrotype*, etc.

In other portions of this work the alkalinity of the nitrate bath (see *Alkalinity*), and of its acidity (see *Acidity of the Nitrate Bath*) are treated; but there are other conditions which affect it and the formation of the image in the film, which require further notice.

Solubility of Iodide of Silver in the Nitrate Bath. Aqueous solutions of nitrate of silver may be mentioned in the list of solvents for iodide of silver. The proportion dissolved is in all cases small, but it increases with the *strength* of the solution. If no attention were paid to this point, and the precaution of previously saturating the nitrate bath with iodide of silver neglected, the film would be dissolved when left too long in the liquid. This solvent power of the nitrate of silver on the iodide is well shown by taking the excited collodion plate out of the bath and allowing it to dry spontaneously. The layer of nitrate on the surface, becoming concentrated by evaporation, eats away the film, so as to produce a transparent, spotted appearance. In the solution of iodide of silver by nitrate of silver, a double salt is formed, which corresponds in properties to the double iodide of potassium and silver in being *decomposed* by the addition of water. Consequently, in order to saturate a bath with iodide of silver, it is only necessary to dissolve the total weight of nitrate of silver in a small bulk of water, and add to it a few grains of an iodide; perfect solution takes place, and on subsequent dilution with the full amount of water, the excess of iodide of silver is precipitated in the form of a milky deposit, which must be filtered out.

Substances which Decompose the Nitrate Bath. Most of the common metals having a superior affinity for oxygen, separate the silver from a solution of the nitrate; hence the bath must be kept in glass, porcelain, or gutta-percha, and contact with iron, copper, mercury, etc., must be avoided, or the liquid will be discolored and a black deposit of metallic silver precipitated. All developing agents such as gallic and pyrogallic acids, the proto-salts of iron, etc., blacken the nitrate bath, and render it useless by reducing metallic silver. Chlorides, iodides, and bromides produce a deposit in the bath; but the solution, although weakened, may again be used after passing through a filter. Hyposulphites, cyanides, and all fixing agents decompose nitrate of silver. Organic matters, generally, reduce nitrate of silver, either with or without the aid of light. Grape sugar, serum of milk containing casein, etc., blacken the bath even in the dark. Alcohol and ether act more slowly and produce no injurious effect unless the liquid is constantly exposed to light. These facts indicate that the nitrate bath containing volatile organic matters must be preserved in a dark place; also that it should be kept exclusively for sensitizing the collodion plates, and not used for floating papers intended for the printing process.

Changes in the Nitrate Bath by Use. The solution of nitrate of silver employed in exciting the collodion film gradually decreases in strength, but not so quickly as the nitrate bath used in sensitizing papers for printing. If the amount of nitrate be allowed to fall as low as 20 grains to the ounce of water, the decomposition will be imperfect, and the film will be pale and blue, even with a highly iodized collodion. A gradual accumulation of alcohol and ether also takes place in the bath after long use, in consequence of which the developing solutions flow less readily over the collodionized plates, and oily stains are apt to be produced. Diminished sensitiveness of the iodide film is sometimes traced to impurities in the bath when it is

very old and has been much used. These are probably of an organic nature and may often be partially removed by agitation with kaolin or animal charcoal. The latter is, however, objectionable, being usually contaminated with *carbonate of lime*, which makes the bath alkaline; or (in the case of *purified* animal charcoal) with traces of hydrochloric acid, which liberates nitric acid in the bath. Even the kaolin may, as a preliminary precaution, be washed with dilute acetic acid to remove the carbonate of lime, if any should be present.

Free Acids in the Nitrate Bath. Strong oxidizing agents, such as nitric acid, greatly diminish the sensibility of the film, and hence the importance of removing the free acid often met with in commercial nitrate of silver. The effect of even a single drop of strong nitric acid in an eight-ounce nitrate bath is appreciable; and when the proportion is increased to one drop per ounce, it will be difficult to obtain a rapid impression. Acetic acid has far less effect upon the sensitiveness than nitric acid, and being found useful during the development of the image is commonly employed; but when great rapidity is required, it should be added cautiously, and in proportion very much less than that in the solution known as the aceto-nitrate of silver, which contains about one drop of glacial acetic acid to each grain of nitrate of silver.

Certain Conditions of the Bath which Affect Development. Attention may be called to a peculiar state of the nitrate bath, in which the collodion image develops unusually slowly, and has a dull-gray metallic appearance, with an absence of intensity in the parts most acted upon by light. This condition, which occurs only when using a newly-mixed solution, is thought by the author to depend upon the presence of an oxide of nitrogen retained by the nitrate of silver. It is removed partially by neutralizing the bath with an alkali; but more completely, by carefully fusing nitrate of silver before dissolving it. Commercial nitrate of silver has sometimes a fragrant smell, similar to that produced by pouring strong nitric acid upon alcohol. When such is the case, it contains organic matter, and produces a bath which yields red and misty pictures. Nitrate of silver which has been sufficiently strongly fused to decompose the salt and produce a portion of the basic nitrite of silver exhibits great peculiarity of development, the image coming out instantaneously and with great force. This condition is exactly the reverse of that produced by the presence of acids, in which the development is slow and gradual. In summing up the different conditions of the nitrate bath which affect the development of the image, as many as *four* might be mentioned, each of which gives a more rapid reduction than the one which precedes it. These are the acid nitrate bath, the neutral bath, the bath of strongly fused nitrate of silver, and the bath containing *ammoniacal* nitrate of silver—which is quite unmanageable and produces an instantaneous and universal blackening of the film on the application of the developer. Greater intensity of image is commonly obtained in a nitrate bath which has been a long time in use, than in a newly-mixed solution; this may be due to minute quantities of organic matters dissolved out of the collodion film, which having an affinity for oxygen, partially reduce the nitrate of silver; and also to the accumulation of alcohol and ether in an old bath producing a short and friable structure of the film.—*Hardwich.*

Sometimes the bath fogs the plate, particularly when new, from the presence of impurities, and works badly in other respects. When the difficulty is not removed by any of the methods already given, submit the solution to the following treatment: Pour the solution into a clear bottle, tie a piece of muslin over the neck, and expose it to *sunshine* for one or two days. This will precipitate most of the organic matter in combination, and the bottom and sides of the bottle will be found to be covered with this purple and brown precipitate. Filter the solution without disturbing the precipitate; test for alkalinity or acidity, and correct either in the manner already described. If upon trial the bath still gives imperfect results, pour it into an evaporating dish, add a little nitric acid, boil it down over a sand-bath and re-crystallize. Re-dissolve the crystals in pure water and make a fresh bath.

Iodine in the Nitrate Bath. Recently the use of iodine in the nitrate bath has been recommended and M. l'Abbé Laborde has written a lengthy paper on the subject. Generally, we endeavor to give the greatest possible sensitiveness to the collodion film, and one of the most efficacious means of so

doing consists in employing a silver bath saturated with iodide, and quite neutral. But this neutrality exposes us to another evil, which we inevitably fall into, if, at the same time, we direct all the other operations toward extreme sensibility; a general veil or *fog* covers the proof, and shows itself principally on the *reserves*. The *reserves* are those parts of the proof upon which the light has not acted. This term will be found very convenient, for it designates without confusion similar effects by the same word, the *whites* of the negative proof and the *blacks* in the positive or glass. We must resign ourselves, therefore, to the loss of some sensibility either by modifying the whole process or by giving to the silver bath a slight acid reaction. M. Laborde has found a new method easily put in practice, and which, in preserving the same degree of sensitiveness in the collodion film, also gives great purity to the reserves. This method consists in introducing some iodine into the silver bath saturated with iodide of silver; about 1 part to 200 parts of liquid. The bath is shaken from time to time; and after a contact of four and twenty hours, a silver bath which has caused the negative to fog will have become regenerated, so to speak. We cannot apply the ordinary laws of chemistry to this fact; or rather, we must search deeper into these laws to find an explanation of it. For every chemist will consider that iodine in contact with nitrate of silver will remove the silver and set some nitric acid free; this acid would then act like most other acids, in opposing the reduction of the silver upon the reserves. But it is found that the prolonged contact of iodine with the silver bath, well saturated with iodide of silver, does not cause it to lose its neutrality; the nitrate bath containing iodine may be heated nearly to ebullition without manifesting subsequently any acidity. We can employ this means if we wish to obtain in a few minutes the whole effect of the iodine upon the silver bath. However, when the iodine has remained fifteen or twenty days in the bath, a yellowish tint may be observed on its surface; the liquid then possesses sometimes a slight acid reaction; but this tint has a secondary action which must be attributed to air contained in the silver bath. The yellow tint manifests itself by markings which correspond to the grains of iodine where the imprisoned air has been drawn into the liquid; and if we see a bubble of air formed on the surface of the iodide, we may observe subsequently that it has disappeared, and become replaced by a yellow spot. In making the experiment in a flat plate inclined so as to put the iodine in contact with the air and the liquid, some iodide of silver will be formed around the fragments of iodine, and the bath will lose its neutrality. From this we may understand that the iodine must be entirely immersed in the liquid, and that it is best to withdraw it when it has produced the desired effect. It is easy to restore the neutral state of the bath by adding some carbonate of silver. We can even leave an excess of carbonate of silver in the silver solution without its losing any of the properties it owes to the presence of iodine; this fact proves still more that they are not due to nitric acid, else we should have to admit the occurrence in the body of the same liquid of the prolonged existence of two substances which mutually attack each other. Besides, we know that the feeblest proportion of nitric acid diminishes much of the sensibility; and if the dose be a little strong, the proof becomes flat, becauses it refuses to strengthen under the developing agent. When the nitrate of silver is not saturated with iodine, matters proceed differently; the iodine removes some silver from the nitrate, and sets some nitric acid free; the iodide of silver dissolves in the silver solution, which soon becomes very acid. We can neutralize it by carbonate of silver, but it is much better to dissolve the iodide of silver in the nitrate, and add the iodine only after complete saturation. The effect of iodine in the silver bath consists probably in preventing that spontaneous reduction upon the sensitive film which often takes place with the luminous action. The silver reduced in advance, called afterward the reduction of the nitrate under the developing agent, without any well-marked preference for the impressed parts when the first reduction has been rather strong, causes a general *fogging*, which really does not cover the image, as it pre-exists, and is formed as promptly as the image. We see by this how important it is to prevent this veil or fog. In this modification of the bath, it is remarked that the proofs solarize with difficulty; to do so, they would require much longer exposure than ordinary. Solarization is doubtless very often attributed to the subjacent veil spoken of above; then we dimin-

ish the time of exposure; thus pursuing a false route from which we can only emerge with mediocre proofs in our hands. Photographers have long known that we must almost always attribute to the silver bath the imperfections which torment us so keenly by the obstinacy with which they reappear; in iodine will be found a powerful auxiliary for avoiding most of them.

Chloric Acid in the Nitrate Bath. The acetic and nitric acids employed in the nitrate bath yield variable results, which are due to their volatility and to their decomposition in presence of the other compounds which are formed in the silver bath by the action of a high temperature. It is this fact which has induced M. Gaudin to employ a fixed and stable acid, which would not, under any circumstances, produce a precipitate. Under this relation chloric acid occupies the first rank. The chlorates are soluble like the nitrates, and when a silver bath is once properly acidulated with chloric acid, it always retains the same acidity notwithstanding the concentration of the bath, or even its complete desiccation. Chloric acid is obtained from chlorate of baryta; it is rather costly, but so little of it is required for the purpose that the price is no object. After making a saturated solution of chlorate of baryta, sulphuric acid is added to it as long as a precipitate is formed. This precipitate is sulphate of baryta, and the filtered solution is chloric acid in a state of dilution fit for use. After preparing a neutral silver bath solution, M. Gaudin employed it for obtaining proofs which came out well with a pyrogallic acid developer more strongly acidulated than usual. Upon the addition of ten drops per litre (35½ fl. ozs.) of chloric acid the silver bath reddened litmus-paper in a very marked degree, and the negative obtained with the bath thus modified came out well with the same time of exposure. He afterward increased the quantity of dilute chloric acid to the extent of 5 per cent. of the volume of the silver bath. A notable diminution of sensibility was the result, but infinitely less than if he had added dilute nitric acid in the same proportion. The diminution in sensibility appeared to be exactly similar to that produced by acetic acid, inducing M. Gaudin to say that dilute chloric acid is the best agent for acidifying the nitrate of silver bath.

Nitrated Paper. Paper prepared with nitrate of silver solutions for photographic purposes. Nitrate papers consist of four kinds: those which have been previously iodized, either for negatives or to print upon by development, usually sensitized with aceto-nitrate of silver (see *Negative Paper*, *Paper Negative Process*, *Waxed Paper Process*, and *Printing by Development*); calotype paper (see *Calotype*); plain paper sensitized with ammonio-nitrate of silver (see *Positive Printing Process*), and nitrated albumen paper (see *Albumen Printing Process*). These are all described and explained under the heads given.

Nitrate of Ammonia. A combination of ammonia and nitric acid made by saturating nitric acid with ammonia. A dilute solution of this salt is employed for cleaning daguerrotype plates (see *Cleaning the Plate*), and, added to the hyposulphate of soda solution in small proportions, for determining the color of photographs upon glass and paper. Used in freezing mixtures.

Nitrate of Barium. $Ba(NO_3)_2$. Waterless octahedrons, stable in the air, soluble in water, insoluble in alcohol. Used in an iron developer for collodion positives and as a test for sulphuric acid in silver baths, with which it forms a white precipitate (sulphate of barium).

Nitrate of Baryta. Nitrate of baryta may be made by digesting carbonate of baryta in dilute nitric acid. It crystallizes in regular octahedrons, which dissolve in 12 parts of cold and 3 or 4 of boiling water, but does not dissolve in alcohol. It may be substituted for the nitrate of lead in the preparation of proto-nitrate of iron.

Nitrate of Bismuth. The super-nitrate or binitrate of bismuth is obtained by evaporating to crystallization the fluid which remains after the formation of the subnitrate.

Nitrate of Camphor. Sometimes called *oil of camphor*. It is prepared by discoloring camphor in nitric acid.

Nitrate of Copper. A combination of peroxide of copper and nitric acid. It is very deliquescent, and must therefore be kept in a tightly ground stoppered bottle. May be used as a quickening agent in the production of glass or paper photographs, but is not of sufficient practical utility to make it of importance.

Nitrate of Iron. Ferrous nitrate. $Fe(NO_3)_2$. Green, very soluble crystals, obtained only from diluted solution. Used

alone or in combination with sulphate of iron as a developer for collodion negatives and positives.

Nitrate of Lead. $Pb(NO_3)_2$. White, waterless salt, very soluble in water, sometimes used in the negative silver bath to make it more sensitive. This salt is composed of 1 part oxide of lead and 1 of nitric acid. It is prepared by digesting metallic lead in nitric acid diluted with 3 parts of water, and exposing the liquid to heat as long as any effervescence continues; filtering the solution and evaporating it till a pellicle forms, then setting aside, when, upon cooling, crystals will form. (See *Hydriodic Salts.*)

Nitrate of Magnesia. This salt is composed of equivalents of nitric acid = 54, and 1 of magnesia = 20 + 6 water = (9×6) = 54 = 128. It is very deliquescent, and is soluble in alcohol. Nitrate of magnesia has been recommended as well adapted for preserving the sensitiveness of collodion plates by keeping them moist during out-of-door operations, while conveying the plate between the darkened room and the camera, or for a longer time if required. The process is as follows: The plate coated with collodion in the usual manner is rendered sensitive in the nitrate bath, in which it should be allowed to remain five minutes; it must then be slightly drained and immersed in a second bath, consisting of

Nitrate of Magnesia	4 ounces.
Nitrate of Silver	12 grains.
Glacial Acetic Acid	1 drachm.
Water	12 ounces.

and these left for about five minutes, then removed and placed in a vertical position on blotting-paper until all the surface moisture is drained off and absorbed; this generally takes place in half an hour; the plate may then be put away in a convenient box until required for use. Before developing it will be found advisable to moisten the collodion film by immersion in the nitrate bath for about half a minute, else the pyrogallic acid or iron solution will not flow evenly over the plate. The fixing is conducted as usual. It is necessary to success that the nitrate of magnesia be quite pure.

Nitrate of Potassium. Potassic nitrate; nitre. KNO_3. Hexagonal, colorless prisms, free from water and stable in the air; soluble in water, almost insoluble in alcohol. Used with sulphate of iron as developer for collodion positives, and with magnesium powder in the preparation of an explosive flash-light compound.

Nitrate of Silver. This is the all-important salt to photography in the present state of the art. It is a compound of nitric acid and silver, and may be prepared as follows: *First*, from pure silver; *secondly*, from coin—the first being the best method, as giving least trouble. 1. Dissolve the silver in nitric acid containing 2 parts of water, evaporate by heat over a sand-bath or spirit lamp to one-half and set the solution aside to cool and crystallize. If any solution remains after standing two or three hours pour it off, drying the crystals thoroughly, and again evaporate and crystallize. Keep the two batches of crystals separate, as the first are much the purest. To get rid of the free nitric acid still present in these crystals re-dissolve, again evaporate and crystallize; repeating the operation until the crystals no longer redden litmus-paper in the slightest degree. 2. Dissolve a given quantity of *coin* (Mexican or South American coins are the best) in nitric acid containing two parts of water, as before. The coin being adulterated with copper, this must be removed as far as possible. To do this, place in the jar of silver solution a plate of copper in size about 2 by 3 inches, or use four or more (according to the quantity of solution) copper coins; the pure metal will immediately begin to precipitate. Allow the action to proceed until a few drops of common salt put into the silver solution does not produce a milkiness; siphon off the clear liquid closely; wash the precipitate with water repeatedly until the water runs off perfectly clear; then re-dissolve the precipitate, which is metallic silver, in nitric acid as before, evaporate by heat, and crystallize in the same manner as first directed. The re-crystallization in this case will, perhaps, have to be repeated oftener in order to get rid not only of the free nitric acid, but also any portions of copper that may remain after the first operation and each solution filtered before evaporation. In both cases the purity may be insured by *fusing.* To do this place the crystals in a clean evaporating dish (Wedgewood ware should be always used), cover it with a piece of glass, and place it over a *very gentle* heat; in a short time the mass will commence to liquefy, and gradually the whole will become fluid. The heat should be continued until there is not a solid particle in the dish, but

not long enough to cause any bubbles, as that indicates decomposition. As soon as alt is quite liquid remove the dish aside to cool. When quite cold dissolve the mass in twice its bulk of pure water, and re-crystallize as before.

In the crystalline state nitrate of silver forms transparent and colorless plates belonging to the right prismatic system. When heated to a temperature below redness it fuses readily—in the manner described above—without decomposition, forming a clear liquid which solidifies on cooling to a white, hard, fibrous mass. Its aqueous solution does not redden litmus-paper, but on the contrary is said to have an alkaline reaction. It has a disagreeable, bitter, metallic taste, and acts as an acrid poison if taken internally. It destroys organic matter if exposed to the light. In 100 parts it contains 63.52 parts of metallic silver, 100 parts of metallic silver yielding 157.4 parts of nitrate of silver. It does not blacken in the air or light, except when in contact with organic matter or gaseous exhalations. Heated to redness it decomposes, yielding metallic silver and various gases. Thrown into red-hot coals it detonates, and takes fire when mixed with powdered charcoal and struck with a hammer. Heated to fusion with zinc or copper it decomposes, but suffers no change if fused in perfectly clean iron vessels if no water is present. Placed in contact with copper, even in the dry state, it is reduced to metal, a change which also takes place if kept wrapped up in paper any length of time. Nitrate of silver dissolves in one part cold and half a part of hot water, the excess crystallizing out on cooling. It dissolves also in four parts of boiling alcohol, the greater part, however, separating on cooling. It is insoluble in strong nitric acid, and is precipitated by that acid from its aqueous solution. It forms a crystalline salt with iodide of silver, and in strong solution dissolves considerable quantities of that and other insoluble silver salts. From its aqueous solution iodide of potassium or iodide of ammonium throws down all the silver in the form of iodide of silver, which is sparingly soluble in excess of iodide of potassium, and almost insoluble in nitric acid and ammonia; the latter, however, turns it white.

The nitrate of silver of commerce is sometimes adulterated both accidentally and intentionally, hence it is better for the photographer to test it where it is possible to do so. Nitric acid is a very common adulteration in the cheaper kinds, and may be detected by the smell, and when strongly adulterated, by the corrosion of the corks of the bottles in which it is kept. The remedy is to dissolve, evaporate, and re-crystallize as before directed, until all acid smell has disappeared. *Nitrite* of silver is also very liable to be present in the fused sample; this may be removed by dissolving, adding a little nitric acid, evaporating, and crystallizing. *Organic* matter is very frequently an impurity in the commercial salt, finding its way in from a variety of causes; the remedy for this is to fuse the silver. Nitrate of copper is also often present, particularly when the salt is prepared from coin; the remedy is given in the *second* process of manufacture, above. Nitrate of potassium, nitrate of zinc, nitrate of lead, etc., are often added by the manufacturer, in order to enable him to undersell the honest dealer. These may be detected in the following manner: Dissolve a drachm of the suspected salt in half an ounce of distilled water, and add pure hydrochloric acid until no more precipitate is formed, agitate well, and filter off. The solution will contain the hydrochloric acid which has been added in excess, free nitric acid resulting from the decomposition of the nitrate of silver and the nitrates which have been used in the adulteration. This may now be evaporated to dryness, and if any solid residue is left it shows that an adulteration of some kind is present. If you want to know what it is, you must dissolve the residue in water and add a drop or more of dilute sulphuric acid to it, when, if a white turbidity is produced, it shows that it has been adulterated with nitrate of lead; in this case add more sulphuric acid until no more precipitate is thrown down, and after agitating the liquid again, filter it into a clean glass. If, however, no precipitate has been produced it need not be filtered. In either case evaporate the solution to about one-fourth of its bulk, and then add ammonia until it is in slight excess; then add a few drops of sulphide of ammonium, and if a white precipitate be produced it shows that nitrate of zinc has been present. If no precipitate appears evaporate the whole to dryness and heat the residue to redness until no more white fumes are given off. Any residue

remaining behind, which will not volatilize at a temperature below redness, will show that an alkali is present, probably potash. If the latter impurity only is present, the silver salt may still be used for making the sensitizing solution for positive printing; the only effect which it will have being to diminish the amount of silver present, which must be allowed for by taking more of the salt. It may also be used for making the nitrate bath for all except the most delicate processes. If nitrate of zinc be present, the salt will be fit for positive printing, but will not be suitable for the collodion process. Nitrate of lead and nitrate of copper will each of them render the nitrate of silver *unfit* for *any* photographic purpose. It is a powerful etching fluid. (See *Residues* and *Wastes*.)

Nitrate of Uranium. Uranyl nitrate. $UO_2(NO_3)_2 + 6H_2O$. Yellow prisms, decomposed in the air; soluble in water, alcohol, and ether. Used for toning gelatino-bromide of silver pictures (red-brown tone), for strengthening negatives (Selles' uranium intensifier), and for sensitizing uranium paper.

Nitrate of Uranium Process. This is a process for positive printing, due to M. Niépce de St. Victor, but improved by M. Godefroy, who gives the following formulas for manipulating:

Float a sheet of paper upon a bath containing both nitrate of uranium and nitrate of silver. The sensibility increases in proportion to the amount of uranium. A convenient formula is

Water	3½ ounces.
Nitrate of Silver	120 grains.
Nitrate of Uranium	2 ounces.

The paper is to be allowed to remain two or three minutes, and then dried. It may be exposed either in a camera or under a negative, and the impression is to be developed by immersion in the following bath:

Water	1 ounce.
Protosulphate of Iron	40 grains.
Tartaric Acid	20 "
Sulphuric Acid	5 minims.

The image is rapidly developed, and can be fixed by soaking in rain water. Exposure in the camera requires three or more minutes. Under the negative it may be exposed from five seconds to a minute, according to the strength and nature of the light; different lengths of exposure producing different degrees of strength and blackness. (See *Uranium Printing Process*.)

Nitrate of Zinc. Nitrate of zinc is obtained by dissolving small pieces of zinc in dilute nitric acid, which occasions a lively effervescence. Heat it slightly and filter it to free it from the iron and carbonaceous matter it may contain. The liquid then gives, by evaporation, crystals in the form of four-sided prisms, which are deliquescent. This salt, added to the aceto-nitrate of silver, plays nearly the same part as nitric acid. It appears to slightly increase the sensibility of the paper and preserves the whites of the proof by precipitating into the texture of the paper a white oxide of zinc, insoluble in water, and which will close up all the pores of the paper. It must not be left long in the iodide bath, because the precipitate might be re-dissolved in the alkaline solution. After taking the paper from the bath, hang it up to dry, and use it upon the ordinary aceto-nitrate paper.

Nitrate of zinc, on account of its deliquescent quality, has been recommended for prolonging the sensitiveness of collodion on glass. Mr. Brookes, who first employed it, recommended that it should be dissolved in a small quantity of water, and the liquid poured over the sensitive plate; he now gives the preference to nitrate of magnesia.

Nitric Acid. This acid is composed of 1 part nitrogen and 5 of oxygen. It may be obtained by distilling saltpetre or nitrate of potash with oil of vitriol. It is found abundantly in commerce; it is used in photography to form the nitrate of silver and the chloride of gold, by its union with hydrochloric acid. It may also be employed to blacken positive proofs, by adding it to the hyposulphite of soda solution. In a diluted state it is employed with rottenstone to clean the daguerrotype plate; 10 to 15 drops to the ounce of water being sufficient.

Nitric acid is a powerful solvent for metallic bodies generally. To illustrate its action in that particular, as contrasted with other acids, place pieces of silver foil in two test-tubes, the one containing dilute sulphuric, the other dilute nitric acid; on the application of heat a violent action soon commences in the latter, but the former is unaffected. In order to understand this it must be borne in mind that when a metallic

substance dissolves in an acid, the nature of the solution is different from that of an aqueous solution of sugar or salt. If salt be boiled down until the whole of the water has evaporated, the salt is recovered with properties the same as at first; but if a similar experiment be made with a solution of silver in nitric acid, the result is different; in that case *metallic* silver is not obtained on evaporation, but silver *combined with oxygen and nitric acid*, both of which are strongly retained, being in fact, in a state of chemical combination with the metal. If we closely examine the effects produced by treating silver with nitric acid, we find them to be of the following nature: First, a certain amount of oxygen is imparted to the metal, so as to form an *oxide*, which oxide dissolves in another portion of the nitric acid, producing *nitrate* of the oxide, or, as it is shortly termed, nitrate of silver. It is the *instability* of nitric acid therefore—its proneness to part with oxygen—which renders it superior to sulphuric and to most acids in dissolving silver and various other substances, both organic and inorganic. Excess of nitric acid (*free nitric acid*) in the nitrate bath tends to lessen the sensibility of the collodion film, but when judiciously used prevents fogging. The nitric acid of commerce is of various strengths, and as it is necessary in photography that the strongest and purest only should be used. If it is necessary to make a test it may be done as follows: Place, say 100 grains of the acid to be examined in a glass tube, and if it be a strong acid it is better to dilute it with six or eight times its weight of pure water, and if solid or crystallized, to dissolve it in a like quantity. A weighed portion of dry, powdered carbonate of soda or potassa, prepared from the crystallized carbonate, by exposing it to a red heat, is then gradually and carefully added, until the acid is saturated, which is known by its ceasing to effervesce, and to redden litmus paper. Great care must be taken not to exceed the quantity necessary for this purpose. After adding each portion, the solution should be well stirred up, and as soon as the effervescence becomes languid, the greatest caution must be observed in adding fresh portions of the alkali. The proper point is arrived at when the liquid ceases to *redden litmus* and *does not alter the color of turmeric paper;* if it turns the latter brown, too much soda has been added, and the operation becomes useless. As soon as the point of saturation or neutralization is arrived at, the remaining carbonate of soda is weighed, and its amount deducted from its former weight will give the quantity consumed, every 53¼ grains of which will represent an equivalent of real acid. *Another method* is to dissolve 100 grains of the carbonate of soda or potassa, prepared as above, in 700 or 800 measures of boiling water, and when cold, make the quantity up to exactly 1000 measures; this forms a test liquid, every 10 measures of which represent 1 grain of the dry carbonate, and every single measure, one-tenth of a grain. This liquid must be applied to neutralize the acid, as described in the first process and the quantity consumed may be read off on the graduated tube.

Nitrite of Lead. Azotite of lead. Yellow crystals, scarcely soluble in water. Used in the negative silver bath to at once obtain very strong collodion negatives with iron—also with gallic acid—development.

Nitrite of Potassium. KNO_2. White needles, soluble in water and deliquescent. Used in the preparation of silvered albumen paper, that will thus keep for a longer time.

Nitrite of Silver. $AgNO_2$. White, nearly insoluble precipitate, formed by adding nitrite of potassium to a silver solution. In silver baths it imparts keeping qualities to positive paper.

Nitrogen. N. Azotic gas. Color-, scent-, and tasteless permanent gas, found among others in air; specifically lighter than the latter.

Nitroglucose. Sugar treated with nitric and sulphuric acids. A small addition of this organic substance to collodion makes the blacks in the negative more vigorous, but reduces sensitiveness. Used also in the preparation of nitroglucose paper.

Nitroglucose Paper. A paper prepared with nitroglucose, then salted and silvered. Formerly much used for enlargements. Like albumen paper, it may be printed out, or partially, and then developed with gallic acid.

Nitro-Hydrochloric Acid. (See *Nitro-Muriatic Acid.*)

Nitro-Muriatic Acid. This liquid is the *aqua regia* of the old alchemists. It is produced by mixing 1 part nitric and 2 parts muriatic acid diluting an equal bulk of water. The oxygen contained in the former

combines with the hydrogen of the latter, forming water and liberating chlorine, thus:

$$NO_5+HCl=NO_4+HO+Cl.$$

The presence of free chlorine confers on the mixture the power of dissolving gold and platinum, which neither of the two acids possesses separately.

Nitro-Prussides of Potassium and Sodium. Common nitric acid is diluted with an equal bulk of water, and when cold, powdered ferrocyanide of potassium is added: 270 parts of the anhydrous acid to 422 parts of ferrocyanide. It is then neutralized with sodium carbonate, and on evaporation gives a crystallization of the nitrates of potassium and sodium, together with the nitro-prusside. The soluble nitro-prussides, by the production of a beautiful violet tint in the presence of alkaline sulphides, afford a very delicate test for the latter. (See *Printing*.)

Nitro-Sulphuric Acid. A mixture of nitric and sulphuric acid. This mixture is employed in the manufacture of pyroxylin.

Nitrous Acid. N_2O_3. An acid, gaseous at common temperature. Forms a variety of salts, of which nitrate of lead, nitrate of potassium, and nitrate of silver are of most importance in photography.

Nitrous Ether. Also called sweet spirits of nitre, hyponitrous ether, etc. It has a pale yellow color, a mixed odor of apples and Hungarian wine, sp. gr. of 0.947 at 60° F., and boils at 60° F.; it dissolves in about 48 parts of water and mixes freely in all proportions with alcohol and sulphuric ether. Collodion is supposed to contain a small portion of nitrous ether, increasing its sensibility.

Nitrous Gas. NO. Nitric oxide; dioxide of nitrogen. A colorless gas, coloring a solution of sulphate of iron dark. Erroneously recommended at one time as an accelerator in development.

Nodal Points. These are sometimes called the centres of admission and emission. M, in Fig. 142, is a double-convex lens; O is its optical centre. Any ray passing through the optical centre, as R R, emerges on the other side parallel to its first direction, R′ R′, as explained elsewhere. If we now prolong R and R in their first direction, they will meet at a point, P, the one nodal point, or the centre of admission, and if the emerging rays are also prolonged they will converge to a point, P′, the other nodal point, or the centre of emission. We recollect that in the pin-hole camera the size of the image compared with that of the object is exactly in the same proportion as the distance from the screen to the hole is to the distance of the object from the hole. These distances represent the two conjugated foci, as there is no deviation of the rays from a straight line, and the two triangles which are to be compared, meet with their apices. But if we have a biconvex lens (Fig. 143) and A B an object, C D its image, it is clear that the conjugated foci are to be measured from the nodal points P and P, and the two conjugated foci are F P and F P—showing how erroneous it is to measure the foci either

FIG. 142.

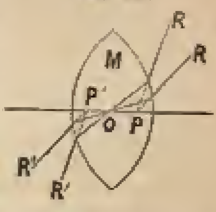


FIG. 143.

from the surface of the lens or from the optical centre. In a meniscus, the one nodal point is situated outside of the lens and the other one inside of the lens. But in a plano-convex lens the optical centre as well as the nodal point are situated where the principal axis crosses the curved side. The plano-convex lens is therefore the only lens of which the focal length can be measured directly. If the plane side is placed toward a very distant object, the distance of the curved side to the image is the principal focus.

Nomenclature. (See *Chemical Nomenclature*.)

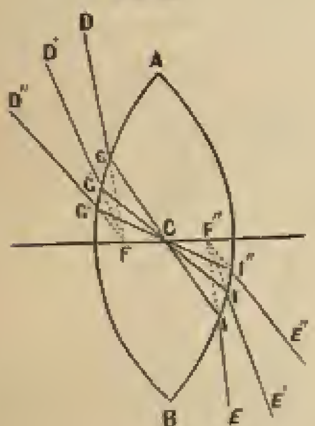
Non-Actinic. Photo-chemically inactive. Yellow and red lights are non-actinic.

Non-Coincidence (of the Visual and Actinic Foci). A lens-defect consisting in the failure of the optical and chemical foci to come together in the same point (see *Aberration* and *Foci*), so that, if one is guided by the optical focus only, the picture will lack sharpness.

Non-Distortion. The first condition of non-distortion is that the pencils of light before and after transmission through the lens are in the same right lines. If the lines are parallel, or coincident, one important condition of non-distortion is fulfilled, and a true image can be secured. If the object is a circle the pencils from it to the lens will represent the surface of a cone, and if they are coincident when transmitted, they will form another cone, a section of which at any part will form a true circle like the object.

The especial property of the optical centre in lenses is this, that any ray passing through it experiences no angular displacement, but has its emergent portion parallel with its incident part.

FIG. 144.



The accompanying illustration (Fig. 144) demonstrates this fully—I E, I′ E′, I′′ E′′, being respectively parallel to D G, D′ G′, and D′′ G′′.

It would thus appear that a common lens with a diaphragm excluding all pencils but those passing through its optical centre would fulfil this condition of non-distortion. Want of flatness, etc., however, practically exclude such an arrangement, and oblige us to resort to compound lenses.

The condition of *coincidence* in the direction of rays before and after transmission is found in the pin-hole camera.

So far for the first condition of non-distortion; but there is yet another.

The pencils transmitted must be such as would have met, if not refracted, at a common point. The reason of this is obvious after a little reflection. If an image were formed by the action of pencils which were emitted toward different termini, it would suffer distortion, like that of a perspective drawing made not from one but from many points of view.

As an illustration, we may compare this action with the effect of combining, to form an image, part of the picture of an object seen with one eye with another part as seen by the other. Now, a glance at the cut will show us that the pencils which pass the optical centre are not such as would have met at a single point, for while the angles of the different rays in the lens, with a common centre C, are in proportion to each other as their area, those formed by prolongation of D G, D′ G′, D′′ G′′ toward F, as refracted rays, are in proportion to each other as their sines. (See *Optical Centre.*)

Non-Halation Plates. These are gelatino-bromide plates so prepared that the danger of halation in their use is obviated. This preparation may consist of coating the plates with more than one film of emulsion, each film being of different sensitiveness to the others; or of staining the emulsion with a colored dye which will wash out in the developing-fixing processes; or of backing the glass side of the plate with an opaque mixture or coating in optical contact with the plates. Non-halation plates so prepared may be obtained commercially.

Non-Inverted Glass Positives. *Plain* non-inverted glass positives may be obtained by the following process: Glass of uniform thickness must be used, a point easily attended to. Supposing a lot a sixteenth of an inch be selected; plane a rabbet a sixteenth of an inch deep around the edges of the plate frame, so that the glass will lie just so much nearer the slide. Lay the plate in, *collodion side up*, and on it place another thin plate, to which small pieces of triangular glass have been neatly cemented at the four corners. Close the box and expose in the usual manner. A rather longer exposure will be required than by the ordinary method, about 16 seconds to 12. Blotting-paper should be laid on the projecting corners of the upper glass plate. A method of *coloring* by which the picture can be viewed from the glass slide of the positive, which represents

the sitter in his true position, has recently been introduced. The method of producing this result is simple, and, when well done, presents somewhat the effect of enamelling on glass. It depends in the first instance, however, on the collodion film being permeable. This is sometimes the case in ordinary positives taken with a collodion, the pyroxylin of which has been made at a high temperature, thus giving a powdery film. This permeable film, however, is much best obtained by the "alabastrine process." The picture having been varnished and colored, and, if necessary, varnished and colored again, a little extra care being used to obtain brilliancy in the carnations, is to be varnished once more with "penetrating varnish," provided for the purpose, which has the effect of projecting the color thoroughly into the collodion film; the result is that the positive when viewed from the glass side presents a picture as vividly colored as on the collodion side. The effect may be still further improved by going over the face again with No. 1 flesh tint. It is important that these pictures should be taken on colorless glass, the ordinary green glass materially injuring the tone of the picture. It must be remembered also that the "penetrating varnish" materially affects the tints of many of the colors. This modification of tint must be allowed for in applying the color, experience dictating the extent of the modification to be expected. Without brilliancy in the color itself no satisfactory effect can possibly be produced. Very little idea can be formed, while coloring the picture on the surface, of the amount of depth or brilliancy of color which will permeate the film. It is, nevertheless, of the utmost importance to know this before applying the "penetrating varnish." An approximate idea may be formed by examining the back of the picture after each application of the alabastrine varnish, before it has dried; from its appearance then a very good idea may be formed of the depth and tint already obtained. To secure the best results some parts of a picture will require more repeated applications of color than others, this depending on the class of picture and intensity required.

The following general suggestions will be found useful in many cases: Color the flesh-tints four times, watching the effect at the back between each coloring, while the varnish is wet, to see that the cold gray of the photograph is yielding to the warm healthy hues of flesh, and that the exact tint of the complexion is being attained; the hair will require coloring once or twice; the draperies, some once, some several times, depending upon the nature of the color and the amount of intensity desired. As a general rule backgrounds will only require coloring once; additional effect may sometimes be gained by repeated colorings; but great care is required in attempting this, as the extensive mass of color in a background is sometimes apt to be moved by the varnish, and run on to the face, etc. Where once is sufficient, it should be done last, as there is no danger of the color being disturbed or running on the application of the "penetrating varnish." The danger of masses of color spreading or running by repeated varnishing is the chief risk to be guarded against, and care must be taken before each additional application of the varnish, to see that no loose color remains on the surface of the picture, but that all the color applied is thoroughly worked in and incorporated with the surface. These pictures should be backed with velvet of maroon or violet tint, instead of black varnish. They should *always* be covered with *colorless* instead of green glass.

Norris' Dry Process. (See *Gelatine Dry Process.*)

Notation. (See *Symbolic Notation.*)

O.

Obernetter Paper. A chloride of silver gelatine paper with free silver, prepared after I. B. Obernetter's formula, and used for prints.

Obernetter's Engraving Process. A negative is taken from the original, and this negative itself is converted into a chloride of silver positive, and then placed in contact with a perfectly flat plate of copper. The quantity of chloride of silver thus deposited upon the metal corresponds exactly to the intensity of the original—in the darker parts there is a denser, in the lighter parts a slighter deposit. By a simple galvanic process (immersion in a galvanic cell kept in action by two of the smallest kind of dynamo machines) the chloride of silver is decomposed and replaced by a soluble chloride and metallic silver. The copper plate is thus hollowed out, the depths corresponding to

the amount of chloride of silver at each place on the plate when placed in the cell. Thus the amount of light and shade depends absolutely upon the proportions of chloride of silver present on that picture, and does not depend at all upon the fancy of the etcher. An advantage Herr Obernetter claims for his process is, that while usually several weeks are required to prepare a printing plate, he can, given a perfect original, prepare the largest size of copper lichtdruck printing plate in a couple of days, from which 21,000 prints can be got, the last as good as the first. Of course, such a plate requires to be frequently re-steeled.

Object. That about which any power or faculty is employed, or something apprehended or presented to the mind by sensation or imagination. Thus that quality of the rose which is perceived by the sense of smell, is an *object* of perception. When the *object* is not in contact with the organ of sense, there must be some medium through which to obtain perception of it. The impression which objects make on the senses must be by the immediate application of them to the organs of sense, or by means of the medium that intervenes between the organs and the objects.

Object-Glasses. A term used by some writers to designate the lenses of the camera. All combinations of glasses, the effect of which is to convey the rays of light passing through them, possess the property of giving on the opposite side a reversed image of any object placed before them. The axis of a lens is that mathematical line which joins the two centres of curvature of the two surfaces. If the object is situated beyond and opposite one of these centres, it throws parallel rays upon the lens, which, passing through, form an image upon the axis, at a point which is called the principal focus. The distance of the frame from the lens is called the focal distance. If the object is at a great terrestrial distance, the image is formed a little farther from the object glass, but very near the principal focus. If the object is placed nearer the lens, the image is formed farther off, and consequently reduced in size; and the nearer the object is placed, the smaller the image will be until it reaches double the principal focal distance; the image is then of the same size, and at the same distance as the object. Then, when the object is placed between the principal focal distance and double that distance, the image is formed between the double focal distance and infinite space—the image being enlarged as the object approaches nearer the focus. When the object is precisely at the principal focal distance, there is no longer an image formed, in consequence of the refracted rays being parallel with the lens; and again, if it is situated between the principal focal distance and the lens, we can no longer have an image, as the rays are divergent. These principles established, it is easy for the photographer who understands the focus of his object-glass to determine with considerable exactness at what distance he should place his camera in order to produce an image the size desired; for, knowing the focal distance of his lens, he will call to mind that, in order to be able to produce the image naturally he should place it at double the distance from the principal focus. Suppose this distance to be one yard: the object will be placed at two yards and the image will be formed, at two yards, of the same dimensions as the object. The operator will remember that the nearer the object is to the lens, the larger is the image; that is, if the focus of the object-glass is of two inches, the object will be placed at twice that distance, or four inches; and the image produced at four inches will be of the same size as the object. If the object is placed at five inches, or two and a half times the distance of the focal image, the image received will be two-thirds the size; if it be at six inches, or thrice the focal distance, the image will be half; if it be at eight inches, or four times the focus, it will be two-thirds. It is thus evident that the denominator of the fraction which expresses the dimension of the image is equal to the number which indicates how many times, less one, the focus is comprised in the distance between the object and the lens.

The photographer will remember that the larger the object, the less luminous will be the image, and consequently it requires a greater length of exposition. He will call to mind that among several object-glasses, *of the same construction*, that which has the shortest focus should be most rapid and sustain the greatest angle. Thus, the *medium* object-glasses, which have only 3.12960 inch focus, sustain an angle of 43 degrees; and an object-glass of 31 inch focus cannot embrace a field as extensive as

the other. These principles are not only necessary to determine the dimensions which should be given to the dark camera, but following we propose to show how views, details of architecture, and very small objects, can be produced, very much enlarged. For this purpose, diaphragms are indispensable; they arrest the more oblique rays, and prevent the diffused light from entering the camera. The distance which separates the diaphragms from the lens, and their apertures, are established by certain rules. The proportions established are these: The diaphragm is placed at an equal distance of one-seventh of the focal distance of the object-glass, and its aperture is one-sixteenth of that focal distance. The operator would then do wrong to increase the size of the aperture of the diaphragm and change its distance from the object-glass. Apart from the slowness which results from a small aperture, the image will be more distinct. We can then only limit the aperture as the angles of the image begin to be obscured. This will prove that it has obtained its minimum. What we have said of the diaphragms for cameras with only one lens, cannot apply to the larger sizes generally used for portraits, and required to operate quickly. These are employed without the diaphragms. No matter what the size of the object-glass, it should have a diameter in conformity with its focus —or, in other words, that which has the largest focus should have the greatest diameter.

Objective Lens. The metal-cased system of lenses on the camera front which projects the optical picture of the model upon the ground-glass and respectively on the sensitive plate. In a telescope or microscope the front lens is called the objective. (The different objective constructions are considered under their respective heads.)

Oblique Rays. (See *Light*.)

Obturator. A French term for the brass cap which covers the front end of the camera tube.

Oil. Presumably a combination of organic acids with a glycerine base. There are solid, volatile, and ethereal oils: Almost all are liquid at common temperature, more or less viscous and insoluble in water. Most of them, when exposed to light and air, absorb great quantities of oxygen and dry up, forming a gummy varnish. These drying oils (linseed, nut, and poppy oils), are used much in painting and for varnishes; fatty oils (for instance, palm oil), do not dry up, but become rancid and acid under similar conditions.

Oilcloth Transfers. To transfer ambrotypes from the glass to oilcloth. (See *Ambrotype*.)

Oil-Ground Photographs. A term applied by Mr. Tatum to his process for rendering canvas susceptible to the photographic impression. This process renders the oil preparation upon the canvas inert for the time being, and the chemicals used for the photographic impression are applied with the same facility as upon paper; after the impression is finished and carefully dried the canvas can be restored to its original oily state, and rendered even more susceptible of receiving the painting in oil than in its original state, as it presents a more *velvety* surface after this treatment.

Oil of Cinnamon. A volatile oil extracted from the bark of the cinnamon tree by macerating for several days in salt water. It is of a yellow or reddish color and very aromatic; nitric acid converts it into a nearly uniform crystalline mass.

Oil of Cloves. From cloves well soaked in and distilled with salt water—the distilled water, after depositing its oil, being returned three or four times into the still on the same cloves. It is colorless or pale-yellowish, strongly odorous and aromatic. The oil of cloves is frequently adulterated with inferior essences, especially those of pinks and clove-gillyflowers, and often with castor oil. The specific gravity of the pure oil is 1.055 to 1.061.

Oil of Coal. (See *Naphtha* and *Petroleum*.)

Oil of Lavender. Made from lavender flowers; it is of a pale yellow, very fragrant: sp. gr., 0.877 to 0.905; the lightest is the best.

Oils—Volatile or Essential. Volatile oils are chiefly obtained from the flowers, leaves, fruit, seeds, bark, and roots of plants by distilling them with water. They are used in photography, in the manufacture of varnishes, and as preservatives from acidity and decomposition of some solutions.

Opacity. A term applied to the negative referring to its density.

Opal Glass. Glass which is polished on one side with an opaque white or which is composed altogether of the white substance is called opal glass. The latter of

these kinds is sometimes called *pot metal.* Both sorts may be had either with a polished or matt surface. Positive pictures may be made on opal glass by various processes; by the wet collodion process a negative may be copied in the camera, which on development becomes a positive picture when opal glass is used as a support. A carbon transparency or a positive by the collodio- or gelatino-chloride methods may also be secured with this glass, either in the camera or by contact printing. Opal glass coated with gelatino-bromide emulsion is obtainable commercially, and may be used exactly as gelatino-bromide paper is employed, and for the same purposes. Matt-surface opal presents an excellent basis for hand work, and beautiful effects in monochrome or color upon a photographic base are easily obtained upon it by skilled workers. *Opalotypes* are pictures produced by any of the above methods on polished or matt opal glass.

Opaque. A pigment of reddish hue invented by Mr. John L. Gihon. As a thin paste it is applied to negatives or any portion thereof for stopping-out, and for various purposes it is used in the photographic printing-room. Figs. 145 and 146 demonstrate effects obtainable by the use of Gihon's opaque.

FIG. 145.

FIG. 146.

Opaque Screen. A portable opaque screen is advised as giving excellent results with the optical lantern. Such a screen is made by straining close together upon a suitable frame a black and a white screen of the usual fabric used. The picture is projected upon the white fabric, and its brilliancy is greatly enhanced by the opaque backing. It is essential that the two screens be in contact.

Opaque Stop or Diaphragm. In order to equalize the illumination falling through the lens upon the plate, Mr. J. T. Taylor advised some years ago the use of a small piece of V-shaped blackened brass placed in the lens tube a little in front of the diaphragm. To this device he gave the name of "opaque stop."

Opening of the Lens Aperture. The diameter of lens and diaphragm.

Opera-Glass Stereoscope. This instrument is nothing more than a double opera-glass.

Operate. A term applied to photographic manipulation.

Operator. A manipulator of the photographic art; a daguerrean artist.

Operating-Room. The dark-room in which photographic manipulations are carried on.

Optics. The science which treats of light and its effects. (See *Lens* and *Light.*)

Optics of Photography. That part of the science of optics relating to the construction of the photographic lens, and the action of light through it upon photographic substances.

Optical. Pertaining to optics.

Optical Centre. Every lens possesses a point, situated in its proper axis, which is called the optical centre. This can readily be found by drawing two radii, *A B* and *C D* (Fig. 147), from the centre of curvature *A* and *C'* of its surface, parallel to each other, but oblique to the axis *A C*, then connect the two extremes *B* and *D*, and the line *B D* or its prolongation will cut the principal axis in *O*, the optical centre. If the lens is a double convex one of equal radii, the optical centre is the centre of the lens, or its centre of gravity. Fig. 148 is such a lens. Now suppose we change

FIG. 147.

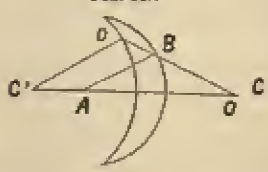
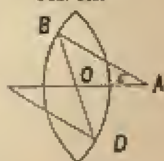


FIG. 148.



one curve into a shallower one, of longer radius: it is evident that the optical centre is shifted toward the predominant, more curved side; and if we continue to make that side shallower, it will gradually move toward *E*, until the surface is converted into a plane, in which case the optical centre is coincident with the point where the axis cuts the curved surface *E*.

Optical Sensitizers. Substances by which silver salts are made sensitive to such colored rays as they absorb. (Eosin, cyanine, chinolin-red, chlorophyll.)

Orange Light. Actinic light filtered through any medium which permits only the passage of yellow rays. Such a light is suitable for many photographic operations.

Organic Bodies. All bodies are called *organic* which possess organs on the action of which depend their growth and perfection, such as animals and plants. The term *organic*, however, is also applied to substances which are obtained by chemical processes from the vegetable and animal kingdoms, although they cannot themselves be said to be living bodies. (See *Organic Substances*.)

Organic Matter. The substances which proceed from or constitute organic bodies. The use of organic matter in facilitating the change of silver salts very early engaged the attention of Sir John Herschel; and from time to time others have employed various organic matters, albumen, gelatine and collodion being the favorite substances. These have been principally used for the purpose of spreading photographic preparations upon glass; but many photographers have used them to advantage on paper also. Great annoyance often arises from the rapid decomposition of the more sensitive kinds of photographic paper, independent of the action of light, which appears to arise from the action of the nitrate of silver or the organic matter of the size. It is evident from experiment that the organic matter of size is the principal cause of the spontaneous darkening of photographic papers prepared with the salts of silver. The most curious part of the whole matter is, that in many cases this change is carried on to such an extent that a revival of metallic silver takes place to all appearances in opposition to the force of affinity. This is very difficult to deal with. Chemistry has not yet made us acquainted with an organic body which would separate either chlorine or nitric acid from their metallic combinations. It is, however, certain that the slow action of organic matter is sufficient under certain circumstances to set up a chemical change, which, once started, progresses slowly, but certainly, until the compound is reduced to its most simple form. (See *Organic Substances*.)

Organic Substances. Substances obtained by chemical process from organic bodies, such as acetic acid, procured by the distillation of woody fibre and alcohol, by fermentation from sugar. Organic substances are numerous, and may be divided into *acid*, *neutral* and *basic*. The *acids* are numerous, such as acetic, tartaric, citric, and a variety of others. The *neutral* substances cannot be easily assimilated to any class of inorganic compounds; as examples, take starch, sugar, lignine, etc. The *bases* are also a large class. They are mostly rare substances not familiarly known; morphine, quinine, and nicotine are illustrations. There are more than fifty elementary substances found in the inorganic kingdom, but only *four*, commonly speaking, in the organic; these four are carbon, hydrogen, nitrogen, and oxygen. Some organic substances, oil of turpentine, naphtha, etc., contain only carbon and hydrogen; many others, such as sugar, gum, alcohol, fats, vegetable acids, carbon, hydrogen and oxygen. The *nitrogenous bodies*, so called, containing nitrogen in addition to the other elements, are principally substances derived from animal and vegetable tissues, such as albumen, casein, gelatine, etc.; sulphur and phosphorus are also present in many of the nitrogenous bodies, but only to a small extent. Organic substances, although simple as regards the *number* of elements involved in their formation, are often highly complex in their arrangement of the atoms; this may be illustrated by the following formula:

Starch	$C_{24}H_{20}O_{20}$
Lignine	$C_{24}H_{20}O_{20}$
Cane Sugar	$C_{24}H_{22}O_{22}$
Grape Sugar	$C_{24}H_{28}O_{28}$

Observe as characteristic of organic chemistry, the apparent similarity in composition between bodies which differ widely in properties. As examples take *lignine*, or cotton fibre, and *starch*, each of which contain the three elements united as $C_{24}H_{20}O_{20}$. The simple method of distinguishing between organic and inorganic substances is, to place the suspected substances upon a piece of

platinum foil and heat it to redness with a spirit lamp; if it first *blackens*, and then burns completely away, it is probably of organic origin. The test depends upon the fact that the constituent elements of organic bodies are all either themselves volatile, or capable of forming volatile combinations with oxygen. Inorganic substances, on the other hand, are often unaffected by heat, or, if volatile, are dissipated without previous charring. In combination with reduced silver, all organic substances generally produce greater density of the negative and greater brilliancy and durability of prints.

Orthochromatic Photography. It is well known that ordinary gelatine plates are not equally sensitive to all colors. Such plates are consequently incapable of reproducing colors in a photograph as they appear to the eye; thus, the yellows, reds, and greens always appear darker in a photograph than they are in Nature, the blues and violets lighter. The disadvantages of this defect in portrait, landscape, and reproduction work will be readily understood. In order to enable the photographer to obtain representations of colored objects with the true scale of tones seen in the original, it is necessary that his plates should be made color-sensitive. This is done in various ways: (1) The plates are immersed in coloring matter, or dyes, such as eosin, erythrosin, cyanine, fuchsin, azaline, aurantia, rose Bengal, quinolin-red, chlorophyll, gallo-cyanine, chrysaniline, etc. An ammoniacal solution of eosin is said to be the best for this purpose. (2) The dye or color-sensitizer may be incorporated in the emulsion before the plate is coated. In such a case it is claimed that the use of a yellow screen placed between or behind the lenses, by which the action of certain rays is diminished, is not always attended by a compensatory effect. But as a general rule the use of a screen is advised whether the plates are prepared by the first or second method. Plates so prepared are called *orthochromatic* or *isochromatic*, from two Greek words meaning "right color," and "equal color." Orthochromatic photography is the process of using color-sensitive plates for the obtaining of photographs of colored objects which will represent the originals in true color values or tones. Orthochromatic and isochromatic plates may be obtained commercially of excellent quality, and are growing rapidly into favor for everyday work. They possess so many advantages, and are so easy of manipulation, that it is not overstating the fact to assert that their use must soon become universal. For those who desire to orthochromatize gelatine plates for their own use the subjoined formulæ will be useful.

Dr. J. M. Eders' Formula. Immerse ordinary gelatino-bromide plates for two or three minutes in

Erythrosin Solution 1 : 500 .	1 to 2 parts.
Ammonia	½ part.
Water	100 parts.

Let the plate dry after bathing before use.

F. E. Ives' Formula. Use any good bromide-collodion emulsion that contains no free nitrate of silver. Coat clean glass plates as usual, and as soon as the emulsion film sets, flow it several times with a strong alcoholic solution of chlorophyll from blue myrtle or plantain leaves, then immerse in water strongly tinted with blue-shade eosin, and keep in motion until smooth. This sensitizes for all colors, including red. A very light yellow screen is sufficient for such plates to secure true color values.

Where a color screen is employed with ordinary or color-sensitive plates, the exposure must be proportionately prolonged; for general use a lemon-tinted screen is best. Suitable screens may be obtained commercially at a trifling cost. In the development of orthochromatic plates as little light, and that only of a deep ruby color, should be used as is possible. Except for this detail and the care required in exposures, the manipulation of orthochromatic plates is exactly similar to that required for ordinary gelatine plates.

Orthochromatic Plates. Light-sensitive plates, sensitized with certain coloring matters, making it possible to photograph colors at their true value, or approximately so.

Orthochromatic Screens. For ordinary landscape work a very bright yellow screen is all that is necessary. A dark yellow, or one of orange shade, would falsify distance. The most suitable place for the color-screen is at the back of the lens-board, sliding it into two grooved cleats, and it should be placed in position when focussing. A light-yellow screen would require an increased exposure of four to six times, depending on the state of the atmosphere—the yellower the light the shorter the exposure. Toward evening it may be dispensed with. The

value of a light-yellow screen is best shown where the vista is slightly hazy, or where clouds are included in the view, the forms being much better rendered.

Use of Screens in Copying Paintings. In this class of work the selection of the proper color-screen is of more importance than in landscape work, and the photographer should be provided with two or three, ranging in tint from a moderately strong yellow to medium and dark orange. Paintings are best photographed in direct sunlight, and by examining the paintings through the color-screen it will not be difficult to determine which one of the screens to select. For instance, for modern French painting consisting of light and brilliant colors, a yellow screen will answer; but with a German or English painting, containing strong reds and dark-blues and green, we would select an orange-color screen, and correspondingly increase the time of exposure.—*From a paper read at the World's Congress of Photographers at Chicago*, 1893, *by John Carbutt.*

Orthochromatic Super-Sensitive Plates. Make a solution of 1 gramme chinolin-red in 50 c.c. alcohol, and 1 gramme chinolin-blue in 500 c.c. alcohol. A red-brown liquid known as Berlin azaline is the result.

Bathe and dry the plate; fume a half-hour, and bathe before exposure in acetic acid, solution 1 to 100. The plate will now be very quick, with stop and yellow collodion screen back of lens, plate backed with steel-blue and glycerine; the exposure will be about sixty seconds longer than ordinary.

Make an iron solution of saturated double proto-sulphate of iron and saturated persulphate of iron.

For fine half-tones and snappy negatives take 45 parts neutral oxalate solution and 2½ parts mixed of the iron solutions each—giving one to nine strength. Stir well, add a pinch of citric acid, and let stand five minutes.

Take the azaline plate and flow over it the well-mixed developer; when at length the lights are visible add 15 per cent. more proto-sulphate solution.

If an oil painting is to be copied, use for much blue tone in it a dark-yellow screen back of lens, and increase the exposure one-fifth; for water-colors one-tenth.

The light must come to the painting, as when the artist painted it, from one direction only.

Some very ancient paintings can only be copied by rubbing all over with glycerine at first, then the picture should be taken out of doors, surrounded by high folding-screens and copied by the light from the sky.—*C. Ashleigh Snow.*

Orthoscopic Lens. An early lens-construction of Petzval intended for landscape and architectural work, consisting of a large convex front lens and small concave back lens. It is about two or three times as rapid as a single landscape lens, possesses great sharpness and depth, but is not free from distortion.

Oscillating Table or Rocker. To avoid the tediousness of keeping the developing solution in constant motion when many plates are to be treated, it is a good plan to attach a swinging weight to the developing-table, so that the oscillatory motion set up by the swinging of the weight will be communicated to the developing-tray. This motion may be kept up by an occasional touch of the hand or foot, or clockwork may be applied for this purpose.

Osmium. A metal found with platinum and iridium in the metallic residue left after treating the ore with aqua regia. Osmium is grayish-blue in color, and is the heaviest body known, being also almost infusible. It has been proposed to tone prints with osmium salts. For this purpose the ammonium-osmium chloride is used. It is a similar salt to the chloro-platinites in some respects. For use, a one-grain solution in water is acidified with acetic acid, and the solution is brushed over well-washed prints. It gives sky-blue tones, afterward passing to brown.

Dr. P. E. Liesegang, who has experimented with this bath, says: "The toning-salt consists essentially of ammonium-osmium chloride, and acetic acid, and is fit for use on simple solution in water. On immersing in the bath a washed-out silver print, it first assumes a brown tinge, after which the half-lights tone a deep azure-blue. Aristo paper tones deep blue-black when acted on sufficiently long, which gives a very beautiful effect, considerably superior to that of platinum prints. The prints ought not to be washed out between toning and fixing."

Ounce. English weight. Apothecaries' weight, used in English recipes, 1 ounce = 480 grains = 31 grammes.

Outdoor Photography. Photographing in the open air.

Outline. The line by which a figure is defined; the exterior line. In drawing, the representation of an imaginary line circumscribing the boundary of the visible superfices of objects, without indicating by shade or light the elevations or depressions, and without color.

Over-Exposure. A fault consisting in allowing the action of the light on the sensitive plate in the camera to continue longer than is required for a perfect picture. Over-exposed plates quickly darken in the development, and after fixing appear thin and flat in consequence of the lack of sufficient development.

Over-Printed Proofs. To reduce such prints on albumen paper the late Adam Salomon used:

Cyanide of Potassium	5 grains.
Liquid Ammonia	5 drops.
Water	1 pint.

Carefully watch the prints, and well wash afterward.

Oxalate. A compound of oxalic acid and a base.

Oxalate Developer. No. 1. Saturated solution of neutral oxalate of potash. To 1000 parts of this add 3 parts saturated solution of bromide of ammonium.

No. 2. Saturated solution of sulphate of iron. To 1000 parts of this add 2 parts saturated solution of tartaric acid.

For use, take 4 parts of No. 1 to 1 part of No. 2. If the picture is under-exposed, add a little more of No. 2.

Oxalate of Iron. Ferrous oxalate, C_2FeO_4, a precipitate from solution of sulphate of iron by oxalate of potash. Yellow crystals. It is soluble in water, but with free oxalate of potash forming a red liquid which possesses great developing powers (oxalate of iron developer).

Oxalate of Potash. $K_2C_2O_4$. Colorless crystals, very soluble in water. Used in oxalate of iron developer and for developing platinum prints. The double oxalate of potash is very difficult of solution in water.

Oxalate of Silver. Silver oxalate, $C_2O_4Ag_2$. White powder, insoluble in water, soluble in nitric acid; light-sensitive. Used in the preparation of gelatino-chloride of silver emulsion for direct prints.

Oxalic Acid. $C_2H_2O_4$. Colorless needles, strongly acid in reaction and very poisonous. Soluble in water, less so in alcohol. Used for acidifying, sensitizing, and developing solution in the platinum process.

Ox-Gall. A bitter fluid secreted by the liver. To prepare it for the artist's use, allow fresh ox-gall to repose for twelve or fifteen hours, decant the clear and evaporate to the consistence of a thick syrup, in a water-bath; then spread it thinly on a dish and expose it before the fire or to a current of dry air until nearly dry. It will keep for years in wide-mouth bottles, or pots, covered over with bladder. For use a little is dissolved in water. When colors work greasily on albumenized or other paper, a little ox-gall may be used with them, being careful not to use too much, as, in that case, it will cause them to sink too deeply into the paper. A diluted solution of ox-gall is used as substratum for dry plates, also to harden the film of clichés.

Oxide. A compound of oxygen and a base, destitute of acid and salifying properties. The oxides unite with the acids, forming compounds called *salts*. To designate the different oxides of the same base, and to mark the number of equivalents of oxygen combined with one equivalent of metal, derivatives from the Greek or Latin are generally employed. Thus, the term *oxide* or *protoxide*, the *deutoxide*, *tritoxide*, etc., are applied to the *first*, *second*, *third*, etc., oxide of the same base; and the last oxide, in which the base is saturated with oxygen, without being *acid*, is called the *peroxide*. In like manner the terms *oxide*, or *protoxide*, *sesquioxide*, *binoxide*, teroxide, etc., denote that the oxygen is in the ratio to the metal of 1 to 1, 1½ to 1 or 3 to 2, 2 to 1, 3 to 1, etc. The Greek numerals *dis*, *tris*, *tetras*, etc., are prefixed in a similar way, to denote oxides formed of one equivalent of oxygen, and with two, three, or more equivalents of metal. More complex ratios are denoted by a fraction, the numerator of which represents the equivalent of oxygen, and the denominator the equivalent of metal. The termination *ous* and *ic* are occasionally employed, the former being applied to the lower and the latter to the higher states of oxidization, as *cuprous* oxide, *cupric* oxide, *ferrous* oxide, *ferric* oxide, applied to the respective oxides of copper and iron. Oxides containing less than one equivalent of oxygen to one equivalent of metal, are commonly called *suboxides*. The same system of nomenclature is also applied to saline com-

pounds, as *protochloride, sesquichloride, bichloride, terchloride, oxalate, binoxalate, sulphate, bisulphate*, etc. (See also *Equivalents, Nomenclature*, etc.)

Oxide of Silver. Protoxide. If a little potash or ammonia be added to a solution of nitrate of silver, an olive-brown substance is formed, which on standing collects at the bottom of the vessel. This is oxide of silver, displaced from its previous state of combination with nitric acid by the stronger oxide, potash. Oxide of silver is soluble to *a very minute extent* in pure water, the solution possessing an alkaline reaction to litmus; it is easily dissolved in nitric or acetic acid, forming a neutral nitrate or acetate; also soluble in ammonia (ammonia-nitrate of silver), and in nitrate of ammonia, hyposulphite of soda, and cyanide of potassium. Long exposure to light converts it into a black substance which is probably a suboxide. The *suboxide* is obtained by exposing a solution of ammonia-nitrate of silver to the air, and is a black or gray powder, which assumes the metallic lustre on rubbing, and when treated with dilute acids is resolved into protoxide of silver, which dissolves, and metallic silver. Oxide of silver dissolves in the nitrate bath and renders it alkaline, hence its application to render the acid bath neutral. A solution of oxide of silver in nitrate of ammonia is sometimes employed for sensitizing paper, instead of ammonia-nitrate of silver, so called.

Oxidizing Agents. Substances which, in combination with other substances, produce oxides of those substances.

Oxy-Calcium Light. A light almost similar to the oxy-hydrogen light, except that the oxygen gas is projected through the flame of spirits of wine instead of hydrogen. There is danger in the use of this light.

Oxy-Hydrogen Light. The name given to the brilliant light obtained by a jet of oxygen gas projected through a flame of hydrogen which is made to impinge upon a disk or cylinder of lime, making it incandescent.

Oxygen. An elementary gaseous body. It can be produced by placing chlorate of potassium in a green-glass retort and heating it nearly to redness over a spirit lamp; or by exposing red oxide of mercury in the same way. With hydrogen, oxygen is used in the production of an intensely actinic light (lime-light).

Oxymel. An acidulous syrup made of honey and vinegar. To prepare it take 1 pound of honey, 11 drachms of acetic acid, and 13 drachms of water. Stand the pot containing the honey in boiling water until a scum arises to the surface, which is to be removed two or three times. Then add the acetic acid and water, and skim once more if required. Allow to cool, and it will be fit for use.

Oyster-Shell Markings. A name given to stains upon wet-plate negatives, caused by too much ether in the nitrate bath and by other contaminating causes.

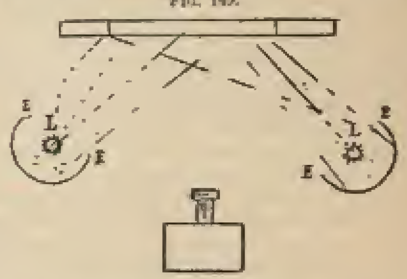
Ozone. Active oxygen; a gas smelling like chlorine. A powerful oxidizer.

P.

Pad. A backing of felt or cloth used in the printing-frame between the sensitive paper and the back of the frame, to equalize the pressure.

Paintings. Photographing these with orthochromatic plates, the following arrangement, with oil or gaslight, is recommended by M. E. Boissonas in the *Bulletin Belge:*

FIG. 149.



L L are two petroleum lamps, placed at the angle shown in the cut, so that the picture will be equally illuminated and no reflections will reach the lens of the camera, placed opposite the picture and behind the lamps. Direct rays are cut off from the lens by the use of the semi-circular reflectors E E, E E. Of course, four or six lamps may be used if desirable. As the light of petroleum is itself strongly yellow, a color-screen is unnecessary, and full orthochromatic effect may be secured with the lamps alone. It was found that in general

an exposure of about sixty times as long as would be given in full daylight was necessary. Gas serves equally well with petroleum as a source of yellow light.

Palladium. A metal found with platinum, which it closely resembles. The salt used in photography is the palladious chloride, $PdCl_2$; used for toning transparencies, enamels, and prints on collodion, silver, and plain paper prints. The following is said to give good results with plain silver paper:

Palladious Chloride	1 grain.
Sodium Sulphite	60 grains.
Water	10 ounces.

The tones obtained with palladium are similar to the familiar platinum tones.

Palladium Chloride. $PdCl_2 + 2H_2O$. A dark-brown crystalline mass. It is used for strengthening collodion negatives.

Panopticon. A philosophical toy by which a succession of figures varying slightly from each other are made to appear as one figure in motion, or in the performance of some regularly recurring action. (See *Stereoscopic Panopticon.*)

Panoramic Camera. A camera invented by Mr. Thomas Sutton was called a "panoramic camera," and was made entirely of brass, and carried in the coat pocket. It was ten inches long and semi-cylindrical, being in its section about half the size of a small tumbler. It was intended for taking six panoramic pictures about 4 x 1½ inches. In the interior there were five partitions which separated the pictures; and in the flat front six jackets (fitted with caps) for the reception of the lens. The pictures were all taken upon a single long curved glass, resembling the one-third part of a tall glass tube cut lengthwise. The lens was changed by putting the hands into a black bag, with which this curious little camera was covered, when changing was required. A larger size for 15 x 6 inch plates was made like any other camera, except that the dark-slide or plate-shield was *curved* instead of being flat, to admit curved glass, upon which the pictures were taken, and "Sutton's panoramic lens" was used. (See *Marcellus Cycloramic Camera.*)

Panoramic Lens. The invention of Thomas Sutton, who wrote of its discovery as follows: I was one day holding up against the light a round glass tumbler half-full of water, and I observed that the objects seen through the water were magnified, while those seen through the empty glass at the top of the tumbler were diminished. Then it occurred to me that a shell of glass having concentric inner and outer circles acts as a concave lens; so, in order to achromatize my sphere of water, I perceived that I had only to make the outer shell of glass *thick* enough and fill the internal spherical cavity with water, and the thing would be done, and there would be no oblique incidences of the marginal pencils, because the lens would still be symmetrical. This idea was ecstatic, and I set to work to carry it out.

Pantascopic Camera. This name was given to a very ingenious panoramic camera invented by J. R. Johnson in 1862. This camera, which rotated on a circular plate, could be made to include the entire horizon upon one plate with equal illumination and definition at all points.

Pantascope. An objective constructed by Busch, of Rathenow, consisting of two equal achromatic lenses of great curvature, including a view angle of 105°; to be used for interiors, architectural pictures, panoramas, etc.

Paper Negatives. Take good Saxe paper. Brush it in all ways with dilute solution of hydrochloric acid of 15 per cent. strength to overcome the transparent spots that so frequently appear during development. Wash free from acid and dry. Make the paper sensitive with iodide of silver by solutions

No. 1.	Silver Nitrate	3 grammes.
	Distilled Water	20 c.c.
No. 2.	Potassium Iodide	3 grammes.
	Distilled Water	20 c.c.

Now pour No. 2 solution into No. 1, stirring constantly, and a precipitate of silver iodide is formed. Allow the precipitate to settle at the bottom of the glass. Pour off the supernatant liquid, add water, stir, and pour off. Repeat this operation four times, when the potassium nitrate should be eliminated to a great degree. Dissolve now the silver iodide in

Water	60 c.c.
Potassium Iodide	30 grammes.

by pouring this solution on the silver iodide and stirring well. The quantity given will hardly effect solution; stir constantly and add crystals of the potassium salt until the solution is of a milky transparency.

Securely pin the paper upon a flat board. A good-sized glass tube is now fitted as a brush in the usual way by means of thread and cotton wool, which must be washed, both thread and wool, in a weak solution of alkali in water, the fibres being afterward carefully rinsed and well dried in a dustless place.

Coat the paper uniformly by brushing in all directions till the surface is surely covered. When but *partially dry* the paper is immersed in a dish of distilled water, all air-bubbles being carefully removed from the surface.

In dish No. 1 soak two minutes, when it must be removed to dish No. 2, and again to dish No. 3.

There should remain upon the surface a primrose-colored silver salt. After three hours' washing hang to dry. Up to this time it has been quite insensitive, so that all operations may be readily conducted in semi-obscurity. There should be at hand a large blank book of C. P. blotting-paper. In this book the sheets may be stored flat until desired for use. When needed pin upon a flat, clean surface, and with a clean brush coat carefully with

No. 1.	Silver Nitrate	6 grammes.
	Glacial Acetic Acid	8 c.c.
	Distilled Water	50 c.c.
No. 2.	Saturated solution gallic acid in distilled water.	

Now, climate acts upon this paper, and in a warm region one must retard the silver nitrate by use of acetic acid (glacial), which is far stronger than acetic acid as commonly understood, but the less acid used the more sensitive the paper. Thus one may, if in the Arctics or northern country, use less, and by experiment can adapt the paper to his environment. To return to our solutions. To every c.c. of No. 1 add 60 c.c. of distilled water, then 1 c.c. of No. 2 and lastly 30 c.c. of distilled water. There must be at high temperature enough water added so that the *immediate* reduction of silver will not take place. Mix the solutions thoroughly. Apply with the clean unused brush *plentifully* to the before-coated iodized paper, and blot off all excess with C. P. blotter. Place now the sheets back to back with a sheet of paper between. The paper is most sensitive when moist; it will, however, give an image dry. To expose in a camera, place between two pieces of glass or gum well upon a piece of glass and it will take the place of collodion film.

Expose until the sky line appears. Develop upon a board with equal parts No. 1 and No. 2 with water as already given. Apply so long as action continues, then brush on No. 2 until shadows dim; quickly arrest, or veiling takes place.

If undertimed use more No. 1; if overtimed more No. 2. Taste, care, artistic knowledge, will enable one to produce a picture, while the rule-of-thumb workman will secure the usual mediocre results. Fix in solution:

Hyposulphite	60 grammes.
Water	1 litre.

One may know when fixation is complete by the disappearance of the yellowish silver iodide. Wash well until hypo is all eliminated, say three hours. Test upon corners for this by iodine test, by brushing a weak solution of the prepared iodine over the back at one corner. The absence of all color denotes the presence of hypo. One *may* test by test-tube, but the test on the back offers security. Dry carefully.

The next step is to prepare the flexible and unbreakable negative for use. Heat an iron (flat iron) so hot as to melt wax readily. Bring a cake of the purest white wax in contact with it, and traverse the negative until it is translucent except the sky. Any excess remove by blotting-paper. Do not overheat, or the grain will show. If any spots come up remove by dilute hydrochloric acid. It is for this reason one must be absolutely certain that no hypo remains in print, for if the acid be applied the picture will go if hypo be present. Wash well after the acidifying.

Absolute cleanliness, careful filtration, the purest of water, must be insisted upon. Try prints for negatives, such as maps. Next a picture with half-tones by aid of gas burner. Then the camera may be used. Light will change. Note-book should show careful record at all hours and seasons. The process is most useful for the traveller, as all needed appliances may be carried with camera and tripod. Dishes that fold may be made of enamelled cloth.—*C. Ashleigh Snow.*

Paper Positives. Impressions taken upon paper from a negative. (See *Papyrograph.*)

Papyrine. Paper resembling parchment and possessing many of its qualities. *To*

prepare, dip white unsized paper for half a minute in strong sulphuric acid, and afterward in water containing a little ammonia; when dried it has the appearance and toughness of parchment. Mr. W. E. Gaine directs the paper to be immersed in strong sulphuric acid diluted with half its bulk of water for a moment, allow to cool, and then wash it in plenty of water, and afterward in weak ammonia. This paper becomes of such extraordinary tenacity that whereas a band of the original paper of about an inch in width breaks under a weight of seven or eight pounds, in its modified condition it will support nearly a hundredweight. This paper is well adapted to papyrographs or positive prints. The impression may be printed after the paper has been treated as above, or the finished pictures may be immersed without fear of injury.

Papyrograph. Photographic positive prints on papyrine.

Papyrotypy. This is a modification of the photo-lithographic process, in which paper is used as the support instead of metal or stone.

Papyrotypy affords a printing process giving black lines on white ground. A paper prepared with chrome-gelatine and dried is exposed in a printing frame under a line negative, placed in an alum solution, dried with blotting-paper, rolled in with lithographic ink. It is then finally washed in water till the ground is pure white. From such a print, if lithographic transfer-ink be used, a number of duplicates may be obtained in the press.

Paraffin. A crystalline, white, pliable mass, insoluble in water; with difficulty soluble in alcohol, very soluble in ether and volatile oils. A solution of it in benzine can be used for polishing paper pictures. Used also on dry cork stopples.

Parallel Rays. Parallel rays are those which proceed equally distant from each other through their whole course.

Paramidophenol. $C_6H_4NH_2OH$. A developing agent chemically allied to hydroquinone and eikonogen, introduced by Andresen in 1891, in the form of brownish crystallized powder, readily soluble in hot water. By the aid of acids, salts are obtained from paramidophenol which are easily soluble in water, of which hydrochloric paramidophenol is an example; this salt combined with carbonate of potash gives an excellent developer. *Rodinol* is the name given to a concentrated solution of one of the salts of paramidophenol, which is the form generally used in this country.

For development with paramidophenol, take

Water	1000 parts.
Sulphite of Soda	200 "
Carbonate of Soda	100 "
Paramidophenol	12 "

This gives an energetic developer, and is specially adapted for short exposures.

Another formula, given by Messrs. Lumière in 1892, is as follows:

Sulphite of Soda (25 per cent. solution)	1000 parts.
Paramidophenol	20 "
Caustic Lithia	5 "

Rodinol, as received in the commercial concentrated form, requires diluting with 50 parts of water for negatives, and 100 parts of water when used for development of bromide paper. The advantages of rodinol as a developer are stated as follows: If the bottled solution becomes discolored its developing power is not impaired; it does not cause the slippery, soapy feeling common with developers when much alkali is used in the bath; does not get "muddy," is clean in action, does not attack the gelatine film or cause frilling, and gives good density and gradation.

Rodinol gives softer negatives than hydroquinone, with a clear gray-black image. Over-exposure can be controlled by the addition of water to the developer in use, or a small quantity of potassium bromide, which, however, must be used carefully.

Parchment Paper. (See *Papyrine*.)

Paste. A solution of starch or wheat flour, made by first mixing with cold water, and then boiling, constantly stirring, until of a proper consistence. Serves to mount photographs.

Paste-Brush. This device is described by Mr. Emil Frey as follows: It is composed of an ordinary wire cork-extractor and a piece of sponge, with a ring. After using the sponge should be removed, washed, and laid aside for future use. A brush of the same construction is helpful in the dark-room for removing the surplus water from dry plates after washing. It will absorb the water and particles of sand more quickly

than a camel's-hair brush. To prevent corroding the wires should be kept dry.

FIG. 150.

FIG. 151.

Pastel Painting. Coloring photographs with pastel colors. The materials employed are soft crayons or chalks of various shades and colors, and some pumice paper stretched on frames, of which there are many sizes, artists preferring pumice paper as being less liable to hurt the skin of the fingers in the blending together of the colors after they are laid on the paper, for in pastel painting the work is entirely done, or ought to be done, with the fingers and the palm of the hand. The intended subject having been lightly sketched in with charcoal, proceed to lay on the colors, always commencing to work from the top, carefully blending them together with the fingers in order to put on the necessary tints. The crayons should not be cut or pointed, excepting when some little finishing touches are desired to be given to the features and hair, but should be gently rubbed on the paper, one color over another, and blended into form with the fingers; by which means a marvellous delicacy and softness can be procured. The shading is done by what is termed cross-hatching. Some pastel painters employ a stump, either of paper or leather, but you will always find that results of a far more satisfactory nature are arrived at by working the entire picture with the fingers alone, and by a careful manipulation of the colors an effect is obtained almost equaling in strength and beauty that of oil colors, combined with that delicacy and transparency which is an essential quality in the highest portrait painting. For all large surfaces, such as backgrounds, etc., the palm of the hand should be used in manipulating the colors after laying them on the paper. It will be found that when working with the crayons they are apt to break of themselves, and the sharp edges thus acquired will be of appreciable benefit in helping the student to produce the form he seeks to achieve. It is important that great care should be exercised in laying on the colors so as to avoid too frequent coatings, which tend toward opaqueness. The chief aim to be sought in pastel painting should be transparency, combined with freshness of color. Different-colored papers are sold for working on with crayons, but that of a yellowish hue is considered the best for pastels. Should it be found necessary to efface any color from the work, recourse should be had to a sable or hog-hair brush, with which the offending color is easily dusted off. Should, however, any small particle still remain on the work, it must be gently blown away. Pastel paintings are usually covered with glass in order to protect them. This is advisable, although there is a way of so fixing the colors as not to make this obligatory.

Pellicle. A thin skin or film; a thin, saline crust formed on the surface of a solution of salt evaporated to a certain degree. This pellicle consists of saline particles crystallized. The name is given to film negatives.

Pen-Drawing. A term applied to a relief-line method upon zinc or copper. "A profession without a professor," says that eminent pen-artist, Joseph Pennell. The materials needed are few, and the skill demanded is considerable.

White Bristol board of good thickness—say 150 pounds—Higgins' waterproof black ink, some J pens for heavy lines, some Gillott's No. 303 and No. 404, and for very heavy work, where blots of ink are left in shadow, a brush to wash them in. Effective work is done by laying flat washes of color or ink over all the pencilled shadows, and then following the same when dry by effective pen-work.

The best work for the pen-artist is Chapman's *American Drawing-Book*, the work being all done in line, the pages 183 to 193, treating of cast shadows, being of special value. Next in usefulness is *Progressive Art*

Studies, by George C. White, parts C and D being very valuable.

The work is best begun by laying in the shadows. Indicate shape and direction with pencil. A good rule for shadows is to let the lines run in the direction of the surface upon which they fall.

For the expression of space use finer pens in the distance than on foreground. Clouds can be easily broken up by Chinese white after lines are dry. Avoid too much cross-hatching. Blue prints from negatives of landscape, or snap-shots of street-life scenes, animals in motion, etc., are easily outlined in the waterproof ink before named. The print when dry can be bleached, leaving the pen-inked outlines. The work can now be finely finished. The size of each should be at least twice as large in drawing as the block is to be when etched. Beautiful initial letters can be done in this manner, which when reduced one-half in the camera will compare favorably with engraved work. Wayside bits, tangled vines, picturesque corners, can all be used to good purpose in this manner, and the beginner can vie with experienced artists in respect to good drawing. Photo-etchers produce relief-line plates cheaply when the drawing is furnished. With a rectilinear lens views of buildings in one's own town, doorways, monuments, interiors, etc., can all be thus produced.

Chalk plates are plates coated with a preparation through which the pen-draughtsman cuts with a point down to the metal. The method of work, so far as line is concerned, is much the same. A bit of thick gelatine is placed over the photograph of any celebrity to be spoken of in the newspaper. With a good point the tracing is carefully made. The lines should be deep and bold. Into these lines now force some *dry* vermilion or ultramarine blue by rubbing with the palm of the hand. Now turn the gelatine over and hold firmly upon the chalk plate and forcibly rub with an ivory paper-folder over all the outlines. The image will be reversed upon the chalk surface. Now cut with the point provided down to the metal. Cross-hatch the shadows under eyebrows, ears, on coat and in hair. The stereotyper can finish a plate in an hour, all blocked ready for locking up with type. By this method any newspaper is easily illustrated from the photograph or blue-print on the *same day* the event described takes place.

Blue-prints of vacation hand-camera rambles are readily outlined, bleached, pressed, and bound with bromide-print covers, toned in sepia or other colors, affording elegant gifts for friends or for exchange with co-workers.

Very artistic pictures are possible, if toned to black and retouched with white and gray in high-lights and half-tones, and then worked up with the pen.—*C. Ashleigh Snow.*

Pen Process-Drawing. (See *Technique.*)

Penetrating Varnish. A varnish which has the property of projecting colors through a substance such as paper or the collodion film. Solutions of Canada balsam in turpentine, or olive oil, or oil of lavender are of this nature. (See *Varnish.*)

Penta-tetrathionate. A salt formed by the union of pentathionic acid with a base, and is produced in the toning bath by the reaction of the sulphurous acid upon the hyposulphite of soda, first forming

Pentathionic Acid. An acid composed of five atoms of sulphur and five atoms of oxygen.

Perchloride of Iron. This salt should be prepared by boiling peroxide of iron in hydrochloric acid and evaporating and crystallizing. The perchloride of iron is sometimes used as a toning agent. The formula is as follows:

Strong solution of Perchloride of Iron	6 fluidounces.
Hyposulphite of Soda	4 ounces.
Nitrate of Silver	30 grains.
Water	8 ounces.

Dissolve the hyposulphite in 7 ounces of water, the nitrate of silver in the remaining 1 ounce; then pour the perchloride of iron into the solution of hyposulphite by degrees, stirring all the time. The addition of the iron salt strikes a fine purple color, but this soon disappears. When the liquid has become again colorless, which it does in a few minutes, add the nitrate of silver, stirring briskly. A toning bath prepared with the perchloride of iron will be ready for use in twelve hours, but it will be more active at the expiration of a week. The solution is acid to test paper, and *milky* from a deposit of sulphur, which must be filtered out.

The addition of silver is made in order to produce a portion of hyposulphite of silver in the bath; the presence of a silver salt having been found to modify the tint of the

positives and to prevent their quickly turning yellow.—*Hardwich.*

Perchloride of Lead. $PlCl_2$. A white precipitate, barely soluble in cold water, very soluble in hot water, concentrated muriatic acid, and especially in hyposulphite of soda. In combination with the latter it serves as a toning-bath for positives.

Periscope. A double symmetrical objective, constructed by Steinheil, including a view-angle of 100°.

Permanence. The property, in negative or positive photographic productions, of resisting the destructive atmospheric agents. (See *Fading.*)

Permanganate of Potash. A red salt, formed by the union of manganic acid and potassa. A dilute solution of permanganate of potash, prepared by dissolving from ½ to 2 grains of the salt, according to its purity, in 1 gallon of distilled water, affords a convenient mode of testing paper positives as regards their power of resisting oxidation; and to an experienced eye it will prove the presence or absence of hyposulphite of soda, the smallest trace of which is sufficient to remove the pink color of the permanganate. It is a powerful oxidizer, decomposing and bleaching organic impurities. It is used, drop by drop, to clear discolored silver-baths; also to strengthen and color carbon pictures.

Permeable. That may be passed through without rupture or displacement of its parts, as solid matter; applied particularly to substances that admit the passage of fluids.

Permeate. To pass through the pores or interstices of a body; to penetrate or pass through a substance without rupture or displacement of its parts; applied particularly to fluids which pass through substances of loose texture.

Peroxide of Hydrogen. Sometimes called oxygenated water, is formed by decomposing peroxide of barium by sulphuric or hydrofluoric acid. It contains twice as much oxygen as water, and is characterized by most remarkable properties. It is a syrupy liquid, sp. gr. 1.45, transparent, colorless, and almost inodorous, but possessed of a most nauseous and astringent taste. It is a powerful bleaching agent, and when applied to the skin for any length of time, whitens and destroys its texture. It can be preserved only at a temperature of 59° F. Heat rapidly decomposes it into water and oxygen gas, and at 212 F. it explodes. The mere contact of carbon, many of the metals and metallic oxides also occasions its instantaneous decomposition, accompanied by an explosion and evolution of light. In the collodion process this substance plays an essential part. It is regularly present at the production of glass pictures, and exercises, according to the conditions, now a favorable, now an unfavorable influence. The action of this body seems to be one of the causes why in the collodion process the sensitiveness of the film is so much superior to others. Peroxide of hydrogen is recommended for removing the last traces of hypo from portraits.

Perspective, Photographic. In a city we must represent a building 80 feet long and 45 feet high to cover 6½ x 8½ plate. What lens shall we use at a distance of 80 feet, at which we are compelled to expose? We desire the image to be 6 inches in breadth. 80 feet × 12 = 960 inches ÷ 6 = 160 times the amount of reduction.

Forty-five feet high × 12 = 540 inches ÷ 160 the amount of reduction will give a building $3\frac{3}{8}$ inches high. 960 the length, ÷ 160 the reduction gives a 6-inch focal length lens. The sky and landscape accessories will fill the rest of the plate.

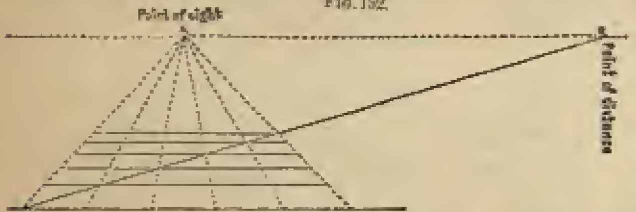
The most pleasing perspective in a picture is secured by the use of such a lens as will project the image upon the ground-glass at a distance of one-half the nominal height of the object from its base.

A word as to size of image. We are using an 8½ inch focus lens. We are distant from a vessel 250 feet long, lying at anchor in the river 200 yards distant. What will be the length of the image on the plate? 200 yards × 3 feet = 600 feet × 12 = 7200 inches. 7200 inches ÷ 8½ feet of lens = 847 times the reduction. Length of vessel is 250 feet × 12 = 3000 inches. 3000 inches divided by 847, the times reduced, gives 3½ inches as the length on the plate. We can remove one lens and get a longer focus. Suppose the image is 2 inches with an 8½ foot combination, and we desire it to be 4½ inches; what should be the focus of the single lens by proportion? As 2 inches : 4½ :: 8½ : $18\frac{1}{16}$ inches the pull of the single lens approximately.

In selecting a battery of lenses for work afield, these rules are an aid in making judicious expenditure for the camera in use.—*C. Ashleigh Snow.*

Perspective, Violent. What is termed violent perspective occurs when objects are next or near to the eyes. They then appear out of proportion with the larger objects in the work, and, although according to rule, they appear false in effect to the eye. To avoid this, a point of distance is chosen that will look

FIG. 152.



agreeable. The farther this point is removed the more level the ground appears, as shown.

Pertinate Stop. A diaphragm for view lenses for the purpose of modifying the light of the sky and the distant parts of the landscape. A disk of card-board or thin metal being cut so as to fit with the cap of the lens, a semi or semi-lunar portion is cut out, and the remaining portion indented like the teeth of a comb; this being placed in front of the lens, and the usual stop being also used behind the lens, the light of the sky is considerably modified and the illumination rendered much more equal.

Petroleum. (See *Naphtha.*)

Petzval's New Lens. (See *Orthographic Lens.*)

Phenol-Phthalein. $C_{20}H_{14}O_4$. Derived from phthalophenone. Colorless substance, insoluble in water, soluble in alcohol. Used in the preparation of test-paper which remains uncharged in organic acids, but reddens in alkalies.

FIG. 153.

Philadelphia Photographer. The name of a magazine instituted in the year 1864, and edited continuously since then by Edward L. Wilson. The engraving is from the obverse of a gold medal offered many years ago to photographers for excellent productions. The periodical is now published as *Wilson's Photographic Magazine*, in New York.

Phenylamine. (See *Aniline.*) Used in the manufacture of cyanin and methyl-orange, which are employed in photography as color sensitizers.

Phosphate. A union of phosphoric acid with a base.

Phosphate of Ammonia. This salt is prepared by adding ammonia to concentrated phosphoric acid until a precipitate appears; after which, by applying heat, the precipitate will be dissolved from the solution, and upon cooling, the crystals will be formed.

Phosphate of Lime. To prepare this salt, take of bones calcined to whiteness and reduced to powder, 1 part; dilute muriatic acid and water, each 2 parts; digest for twelve hours, filter and precipitate by liquor ammonia; well wash the precipitate and dry it.

Phosphate of Lithia. To prepare this salt, add phosphoric acid to a carbonate of lithia, warming the solution, when the carbonic acid will be expelled and the phosphate of lithium is precipitated in white flocks.

Phosphate of Silver. A compound resulting when phosphate of soda is added to the nitrate of silver. This salt is composed of 1 part of oxide of silver, and 1 part of phosphoric acid. It was first applied to photographic purposes by Mr. Fry, but with limited success. Dr. Fyfe gives a process for preparing paper for photographic use, as follows: "The paper is first soaked in the phosphate of soda and then dried; after which the nitrate of silver is spread over one side with a brush; the paper again dried, and afterward again put through the salt, by which any excess of silver is converted by phosphate. As thus prepared, it acquires a yellow tinge, which becomes black by exposure to light." Dr. Fyfe has given a process for applying the phosphate of silver, mixed as a paint, on metal, glass, or paper. It, however, requires the skill of an artist to produce an even surface, and unless a uniform ground is given the picture is deformed by waving lines of different shades. (See *Phosphate Printing Process.*)

Phosphate of Sodium (of soda). Na_2HPO_4, colorless bars, decomposing in the air, and

very soluble in water. Reaction alkaline. Used in the toning-bath for counteracting acid (blue-violet tones).

Phosphate Printing Process. An obsolete process, the invention of Mr. Maxwell.

Phosphorescence. The property of certain bodies to be luminous in the dark after having been exposed to light for a while. To this class belong sulphide of calcium, the diamond, fluss-spath, white paper, and egg-shells. Phosphate of lime and some varieties of fluss-spath become phosphorescent by heat also. (See *Luminous Paint*.)

Phosphoretted Hydrogen. Phosphoretted hydrogen gas affects the revival of metal silver, and the surface produced by its means is of a fine steel-blue, which color arises from a portion of phosphorus having entered into combination with the silver. Owing, however, to the danger of using this gas, it is not safe to operate with.

Phosphorography. The photographic reproduction of pictures directly or indirectly luminous in the dark by contact upon a phosphorescent surface. Warnerke's sensitometer works on this principle.

Phosphoroscope. This instrument, the invention of M. Becquerel, consists either of a disk or a cylinder about an inch in diameter, and six or seven inches long, so arranged that a portion of its surface shall be inclosed within a tight box containing an electric light, and about three-fourths of the surface exposed to the view of a spectator in a dark-chamber, the spaces between the box and cylinder on either side being carefully covered with black velvet so as to prevent the passage of light. The cylinder covered with the substance to be examined is then made to revolve about three hundred times in a second, and as a twentieth part of a revolution would be sufficient to bring a portion of the cylinder from the inside to the outside, it is evident that a phosphorescent effect lasting only one sixteen-hundredth part of a second would become visible.

Phosphorus. A non-metallic element found distributed throughout the animal and vegetable kingdoms. Insoluble in water; soluble in ether, benzine, turpentine, and bisulphide of carbon. If a solution of phosphorus in bisulphide of carbon is prepared and poured over a lithographic stone, and this dried in the dark, a surface sensitive to light is obtained. Such a surface, printed under a negative for half an hour, and washed with bisulphide of carbon, gives an image which will take lithographic ink, and may be printed from in the usual way.

Photo-Chemical Induction. Chemical affinity, or the force which regulates the chemical combination of two bodies, is like all other forces, a certain definite quantity. Hence it is erroneous to say that under different circumstances the same body can possess different affinities; more correctly we should say, that in the one case the bodies are able to follow the chemical attraction of their molecules, whilst in another case opposing forces render this combination impossible. These opposing forces may be considered as resistances similar to those exerted in the passage of electricity through conductors, in the distribution of magnetism in steel, and in the conduction of heat. We overcome these resistances when by agitation we increase the formation of a precipitate, or by insolation effect a decomposition.

We call the act by which these resistances to combination are lessened, and the formation of a "chemical compound" promoted, "chemical induction;" and we specify this as a photo-chemical, thermo-chemical, or idio-chemical, according as light, heat, electricity, or pure chemical action is the force which promotes the combination.

Photochemigraphy. A process of making, in a photographic way, zinc cliches printable in a printing-press, from line-drawings (without half-tones). The negative is either printed on a light-sensitive zinc plate or transferred to it by means of transfer-paper. The plate is then etched, the picture appearing raised. It is printed from the same as a woodcut.

Photo-Chemistry. That branch of the science of chemistry which treats of the phenomena of photography. It is divided into three parts; 1. The *Theory* of photographic processes; 2. The *Practice*, or manipulating details; and 3. The *Laws* of chemistry, with the principal *properties* of the substances, elementary or compound, which are employed in the art.

Photo-Chloride. $Ag_2Cl_2Ag_2O$. (Hodgkinson). The brown product formed from chloride of silver by exposure to light. According to Carey Lea, a chemical combination of chlorate and chloride, which is said to be more stable than the pure chlorate. He discriminates according to the color of photo-

chlorides, considering the pink modification as best adapted for heliochromy.

Photo-Chromo-Typography. The name given in Europe to the process by which prints in colors are produced in the printing-press from two or more photo-engraved relief blocks.

Photo-Chromatic Printing. This is a process for printing photographically upon textile fabrics, and is the invention of Mr. R. Smith, of Blackford, England, who gives the following imperfect account of his process:

A tissue, vegetable or animal, no matter which, plunged in a chemical solution, then dried in obscurity, is made sensitive to the action of the light. It is then exposed to the light, in the presence of the model to be reproduced; and after undergoing the actinic action of the solar rays it is placed in a solu- which develops the colors and renders them permanent; this is the fixing operation, after which it is washed, etc.

The machine for printing is composed of a simple rectangular frame mounted on feet like an ordinary table. This frame has on one side a roller, and on this roller the stuff is wound, properly prepared to be printed on.

From this roller the stuff moves on the table and passes under a sheet of glass, on which, by means of a combination of opaque or transparent pieces, scraps of paper for example, a design has been drawn for reproduction. Every portion of the fabric that the pane of glass covers remains under it long enough to undergo the chemical action of the light, and it is easily understood that this acts on those portions of the fabric which remain exposed to the solar rays, those portions which are sheltered behind the scraps of paper forming the design being necessarily preserved. As long as the exposure continues the fabric remains in contact with the lower face of the glass. This contact is thus obtained: the exposed portion of the stuff lies on a cushion composed of deal-board covered with several folds of flannel, and two springs one at each end press this cushion against the glass.

As soon as the chemical action is produced, being recognized by the exposed surface becoming white or brown, according to the sensitive preparation of which use has been made, the workman lowers the cushion by the aid of a lever, the fabric is released, a new portion of the material takes the place under the glass vacated by the portion printed, which passes to the fixing operation.

To this end this last is carried by two guiding rollers under the table into a trough containing the solution which develops the impression. This piece is drawn through the trough by a couple of cylinders forming a rolling-mill, and which the workman moves by hand, by the aid of a crank, as soon as he has lowered the cushion as just related. The fixing is thus effected, it remains to wash the stuff. This is done at once, as the cylinders forming the rolling mill guide the material into a vat filled with water. The principal colors obtained by this curious process are red, yellow, purple, blue, white, and green. To produce a design pale-blue on a white ground or white on a blue ground, he uses the solutions of the citrate or tartrate of iron and the ferrocyanide of potassium: the stuff is afterward plunged in a diluted solution of sulphuric acid. Brown or buff tints are obtained with a solution of the bichromate of potassa.

The salt which impregnates the parts on which the light has not acted being taken away by the washings, these parts remain white or are decomposed by a salt of lead, to form a yellow chromate of the metal. By combining the two processes and by adding more madder, logwood, etc., an infinite variety of shades can be produced. The exposure to the light varies from two to twenty minutes according to the process used and the subject treated.

Numerous experiments prove that the light of a dull day in winter has all the required power; very handsome patterns have been produced as late as four o'clock in the afternoon in the month of January. A certain number of machines ranged alongside of each other can be superintended by a single workman. The experiments, moreover have been made on the greatest scale that can be given to textile fabrics. Dyed and dress articles have been printed with the greatest success.

Photochromanic. One of the terms applied to the process of photography in the natural colors. (See *Heliochromany.*)

Photocollograph. A photograph in natural colors. Also prints made by Albert's *photolithographic* process.

Photocollotype. The same as Photocollograph.

Photodrome. A scientific instrument for producing negatives by flashes of light.

Photo-Dyeing, or Photo-Tincture. In 1891, M. Villani, of Paris, devised a very beautiful process by which may be obtained prints in colors upon paper or fabrics. This is a process based on the experiments of Kopp, the sensitive salt being bichromate of ammonia, to which is added metavanadate of ammonia.

The material to be dyed is immersed in the following bath:

Bichromate of Ammonia .	50 grammes.
Metavanadate of Ammonia .	5 "
Water	1000 c.c.

After immersion it is dried at a temperature of from 25° to 30° C., and is then ready for exposure. It is exposed under a negative until the details appear clearly defined, then thoroughly washed to remove all traces of the unaltered salts, and may then be either dried and put away to be dyed at some future time or placed at once in the dyeing-bath.

Before dyeing it should be steeped in warm water.

Numerous coloring matters can be used (artificial alizarin, anthracene-blue, alizarin-green, yellow, orange, maroon, etc.).

The prints are placed in a boiling solution of the dye for from ten to fifteen minutes, and are then taken out and washed; if the whites are then not pure the print is passed through a warm bath of carbonate of soda, or a cold bath of chloride of lime, to which a few drops of hydrochloric acid have been added. After a thorough wash the print is finished, and is said to offer great resistance to the action of light, alkalies and acids.

Photo-Electricity. The production of electricity by light.

Photo-Filigrave. A process invented by W. B. Woodbury, by which an image was impressed upon paper, which, viewed by transmitted light showed the effects of light and shade. This was effected by attaching to a metal roller a gelatine relief, so that when passing sheets of paper between the relief and a second roller, the impression produced upon the paper was similar to a *water-mark*, but with half-tones in place of the lines.

Photo-Galvanography. A process of making copper-print and book-printing plates with the aid of photography. A chrome-gelatine film is printed under a negative or diapositive and then successively washed in different baths, graded as to warmth, and in a weak borax solution. The distinct but soft relief formed in this way is hardened in alcohol, coated with fine copal varnish, placed in a tanning solution and dried by heat. The now perfect relief is given a metal surface and duplicated by galvanism or some other process for making casts.

The earliest attempt in the art of engraving upon metal by means of photography and electricity was made by Mr. Fox Talbot, at first proving unsuccessful, but in subsequent efforts he succeeded by means of a process to which he gave the name of *Photoglyphic Engraving* (which see), in producing very fair impressions. In the interval several scientific men have experimented in the same direction, and to Mr. Paul Pretsch we are indebted for the art of *Photo-Galvanography*, which has proved by far the most successful. The art is still, however, in its infancy, and will have to be greatly improved before it can be made practically useful.

Mr. Pretsch's process, with its most recent modifications, is as follows: Mr. Pretsch takes a plate of glass, and on that spreads a coating of common glue or gelatine, to which bichromate of potash is added, together with a small quantity of nitrate of silver. For instance, he takes two or three solutions of glue, into one of which he puts a little nitrate of silver, into another bichromate of potash, and into another iodide of potassium. He uses the silver and potassium for the purpose of producing a little iodide of silver on the sensitive film, so as to produce on the picture that grain which is necessary for holding the ink in the process of printing. He then takes the photographic picture, obtained by any of the photographic processes, and this being placed on the sensitive surface, is exposed to the action of light. In the course of a short time we have a combination of bichromate of potash and gelatine in two different states, one soluble and the other insoluble. Consequently, the plate is then put into water, and all the parts which remain soluble are dissolved out, whilst the other parts remain as they were; and we have the picture produced not only in different lights and shades, but also in different depths, the film being eaten into by the process. When the plate is prepared to this point there is poured upon it a prepa-

ration of gutta-percha, which, being kept under pressure for a short time, receives the reverse image of the photographic picture. This is now prepared for the voltaic battery, by being simply rolled over with fine black-lead; and it being placed in connection with the trough, copper is precipitated on the plate, which receives an image the reverse of the mould. Then by the ordinary electrotype process another plate may be obtained, from which prints may be printed. (See *Pretsch's Engraving Process*, *Photogravure*, etc.)

Photogene. A powder prepared from calcined cuttle-fish bone, and used by many daguerreans to polish the plate. It is used in precisely the same way as rottenstone.

Photogenic. The property possessed by substances to receive impressions by the action of light.

Photogenic Action. The influence of light upon sensitive substances in the production of images of objects.

Photogenic Drawing. The impression made by an object upon a sensitive substance through the agency of light.

Photogenic Effect. The effect produced by the action of the sun's rays upon a substance by which a change in its nature is produced.

Photogenic Substance. Any substance changed or darkened by exposure to light.

Photogen Light. A peculiar light, invented and patented by Mr. John Maule, of England, for taking photographs at night. Other lights have since been introduced equally good, and which are not patented. (See *Lime-Light*, *Magnesium*, etc.)

Photoglyphic Engraving. This term has been applied by Mr. Talbot to his process for engraving upon metal by the aid of photography. In this process, plates of copper, steel, zinc, etc., are employed. Before using a plate it should be well cleaned, and then rubbed with a linen cloth dipped in a mixture of caustic soda and whiting, to remove all traces of grease, and finally rubbed dry with a piece of clean linen. Then cover the plate with a solution of gelatine in hot water, ¼ ounce gelatine to 8 ounces of water, to which add 1 ounce, by measure, saturated solution of bichromate of potash, well strained through linen. After pouring on the mixture the plate is held vertical to get rid of the superfluous solution; it is then held horizontal over a spirit lamp, and the film dried. The object to be engraved is then laid upon the plate and screwed down upon it in a pressure-frame; it is placed in the sunshine for from one to several minutes according to circumstances. When the frame is withdrawn from the light, and the object removed from the plate, a faint image is seen upon it. Next spread over the surface of the film, carefully and very evenly, a little finely powdered gum copal (or common resin); a very thin layer must be used; it is then held horizontally over a spirit lamp (film upward) in order to melt the copal. The melting of the copal is known by its change of color. The plate should then be withdrawn from the lamp and suffered to cool. The gelatine being thus covered with a layer of copal, disseminated uniformly and in minute particles, the etching liquid is to be poured on. This is prepared as follows: Muriatic acid is saturated with peroxide of iron, as much as it will dissolve with the aid of heat. After straining the solution, it is evaporated until it is considerably reduced in volume, and is then poured off into bottles of convenient capacity. As it cools it solidifies into a brown semi-crystalline mass. The bottles are then corked up and kept for use. When a little of this is taken from the bottle in the form of a dry powder, and laid upon a plate, it quickly deliquesces. In solution in water it forms a yellow liquid in small thicknesses, but chestnut-brown in greater thicknesses. To use this mixture, make three solutions: Bottle No. 1, filled with a saturated solution; No. 2, with a mixture consisting of 5 parts of the saturated solution and one part of water; No. 3, with equal parts of the saturated solution and water. Before attempting an engraving of any importance, it is almost essential to make preliminary trials, in order to ascertain that these liquids are of proper strength. When the plate has become perfectly cold it is ready for the etching process, which is performed as follows:

A small quantity of the solution in bottle No. 2 is poured upon the plate and spread with a camel's-hair brush evenly all over it. The liquid penetrates the gelatine wherever the light has not acted on it, but refuses to penetrate those parts upon which the light has sufficiently acted. In about a minute the etching is seen to begin, which is known by the parts etched turning dark-brown, or black, and then it spreads over the whole plate, the details of the picture appearing

with great rapidity. It is not desirable that this rapidity should be too great, for in that case it is necessary to stop the process before the etching has acquired sufficient depth. If therefore the etching on trial is found to proceed too rapidly, the strength of the liquid in bottle No. 2 must be altered (by adding some of the saturated solution to it) before it is employed for another engraving. But if, on the contrary, the etching fails to occur after the lapse of some minutes, or if it begins, but proceeds too slowly, this is a sign that liquid in bottle No. 2 is too strong and too nearly approaching saturation. To correct this a little water must be added before it is employed for another engraving. But in doing this, the operator must take notice that a very minute quantity of water added after, makes a great difference, and causes the liquid to clot very rapidly. He will, therefore, be careful in adding water, and not do so too freely. When the proper strength of the solution in bottle No. 2 has been thus adjusted, which generally requires three or four experimental trials, it can be employed with security. Supposing then that it has been ascertained to be of the right strength, the etching is commenced as above mentioned, and proceeds until all the details of the picture have become visible, and present a satisfactory appearance to the eye of the operator, which generally occurs in two or three minutes, the operator stirring the liquid all the time with a camel's-hair brush, and thus slightly rubbing the surface of the gelatine, which has a good effect. When it seems likely that the etching will improve no further it must be stopped. This is done by wiping off the liquid with cotton-wool, and then rapidly pouring a stream of cold water over the plate, which carries off all the remainder of it. The plate is then wiped with a clean linen cloth, and then rubbed with soft whiting and water to remove the gelatine. The etching is then found to be complete.

Or, pour upon the plate a small quantity of solution from bottle No. 1, which should be allowed to rest upon the plate for two minutes. It has no very apparent effect, but it acts usefully in hardening the gelatine. It is then poured off, and a sufficient quantity of No. 2 is poured on. This effects the etching in the same manner as before described, and if this appears to be quite satisfactory, nothing further is required to be done. But it often happens that certain faint portions of the engraving, such as distant mountains, or buildings in a landscape, refuse to appear, and as the engraving would be imperfect without them, the operator in that case should take some of solution No. 3 in a little saucer, and without pouring off the liquid No. 2, which is etching the picture, touch with a camel's hair brush, dipped in No. 3, those points of the picture where he wishes for an increased effect. This simple process often causes the wished-for details to appear, and that sometimes with great rapidity, so that caution is required in the operator in using No. 3, especially lest the etching liquid should penetrate to the parts which ought to remain white. These operations must all be performed in the dark-room.

Photogrammetry. Photographic survey; a method to mathematically construct from photographs the dimensional proportions of the represented objects for maps and plans.

Photographer. One who practises the art of photography.

Photographers' Association of America. An organization of photographers instituted in the year 1878. Its assemblies are annual in the different cities, and at these times a convention and an exhibition are always held.

Fig. 154.

The seal of the P. A. of A.

Photographic. Pertaining to the art of photography; thus elements and substances which produce photographic effects, or are sensitive to light, or objects which give photographic images are said to be photographic; and all those which resist the powers of photography are termed non-photographic.

Photographic Agents. These consist of the chemicals and other substances used in

the photographic art, and comprise all that are subject to change by the action of light.

Photographic Camera. (See *Camera.*)

Photographic Chemistry. (See *Photo-Chemistry.*)

Photographic Composition. The art of combining objects in Nature, animate and inanimate, by means of photography, so as to form a perfect, pleasing, and artistic picture, and without the aid of the pencil. Taste alone can be the guide to artistic composition.

Photographic Copies. Fac-similes made by photography of paintings, engravings, drawings, and other works of art.

Photographic Delineation. The representation of objects in Nature or art by means of photography.

Photographic Enamelling. This process is the invention of M. Joubert, of France, and is based on the known action of light on the salts of chromium in combination with organic matter. A solution of bichromate of ammonia of the strength of 1 ounce to 4 ounces of distilled water is prepared by heat. Of this 5 parts are added to a mixture of honey, albumen, and distilled water prepared as follows: 3 parts of good honey are melted at a temperature not exceeding 100° F., and mixed with an equal measure of well-beaten white of eggs, which has stood about eight days. After these have been intimately mixed, 30 parts of distilled water are added, and then the before-mentioned 5 parts of the bichromate solution. After filtration the mixture is ready for use, and should be kept in the dark. This preparation forms a solution about the consistence of collodion, and is poured on a well-cleaned glass plate in a similar manner. This coating must be dried by means of gentle heat in the dark-room; it is then ready for exposure. The negative, or what supplies its place, must consist of a transparent positive on glass or paper; an ordinary albumen print, well waxed, will serve the purpose admirably; drawings, engravings, etc., treated in the same way will answer the same end. The negative being placed in the pressure-frame in the usual way, the prepared glass is laid upon it and fastened down as in paper printing. The exposure varies with the light, about a minute in the bright sunshine being sufficient. On returning to the dark-room a slight image is visible to the practised eye. The action of the light has been through all the transparent parts of the superposed transparent positive, or what are to constitute the lights of the enamel positive. The effect of the light has been to harden such parts, whilst the parts in shadow retain a sticky surface, just in such degree and proportion as they have been protected from the light. The plate now possesses a particularly adhesive or sticky surface, the positive being formed by the various gradations of adhesiveness.

The next step is analogous in some respects to the development of a latent image; not by chemical deposit, but by the mechanical application of a vitreous color. A very finely-ground enamel color of any tint is applied by means of a large camel's-hair brush. This adheres to the surface of the picture in proper gradation, at once producing a pictured copy of the original. In the mechanical application of color, many of the characteristics of the picture are under the control of the manipulator, and afford opportunities for the exercise of considerable artistic taste. Vigor can be given to some parts by more copious application of the color, and tenderness and delicacy to others by sparing it; whilst vignetting, etc., can easily be effected. When this part of the process is completed, alcohol, to which a little nitric or acetic acid has been added, is poured on to the surface carefully, and after flooding, the whole poured back again; this process is repeated with alcohol without acid until the film is well soaked. It is then slowly dried. When quite dry the plate is immersed in clear water containing a little carbonate of soda; by this washing the yellow tint of the chromic salt is removed, and the picture appears bright and clear as a transparent positive by transmitted light. When dry it is ready for burning and is placed in the muffle; the enamel color applied being fused and combined with the glass.

When several colors are required in one design or picture, they can be produced by repeating the process with several negatives, each having the parts for different colors stopped out. The combinations of colors which may thus be produced need only be limited by the nature of the materials; the precaution, of course, being observed to use those colors which require the highest degree of heat before they melt, first, each successive color fusing at a lower temperature, so

that they may be fired without danger to the first applied enamels. (For the method of burning-in enamels, see *Burnt-in* or *Ceramic Photographs*.)

Photographic Engraving. (See *Photo-Galvanography*, etc.)

FIG. 155.

Photographic Hall. This building was erected in the year 1876, at the Centennial Exhibition, or World's Fair, in Philadelphia, and was devoted exclusively to the exhibition of photographs from all parts of the world. It contained the finest collection ever known to be exhibited. The building cost nearly $20,000. Mr. John Carbutt was the superintendent during the exhibition. A number of the leading photographers of America subscribed for a portion of Centennial stock in order to supply funds for and to secure the support of this famous building. The idea was originated by Mr. Edward L. Wilson, who personally directed its erection.

Photographic Image. The image of objects produced on any substance by means of photography.

Photographic Ink. A mixture of substances as a substitute for the ordinary ammonio-nitrate of silver, mixed as follows:

Pure Silver	1 part.
Nitric Acid	1½ parts.
Acetate of Potassium	1½ "
Zinc or other metal	1/32 part.

As the formula shows, the mixture is nothing more than adulterated nitrate of silver.

Photographic Negative. (See *Negative*.)

Photographic Optics. (See *Optics of Photography*.)

Photographic Positive. (See *Positive*.)

Photographic Processes. The methods by which photographic pictures are produced. These processes are divided into *negative* and *positive*, and these are subdivided—albumen negatives, collodion negatives, gelatine negatives, and waxed paper negatives, glass positives, paper positives, melainotypes, and various other styles, all of any consequence being given in this work under their appropriate heads.

Photographic Rifle. A device to take photographs of birds of flight.

Photographic Transparencies. Positive pictures on glass and other substances to be viewed by transmitted light. These are either taken direct in the camera or printed from a negative by superposition. (See *Printing Transparencies*, *Transparencies*, and INDEX.)

FIG. 156.

Photographic Trimmer, Robinson's. This invention of Professor S. W. Robinson consists of a handle and a post with a revolving pivot and a wheel inserted in a slot. The wheel is of steel with bevelled edge. It will follow a guide of curved shape and trim the photograph neatly and quickly.

Photographometer. An instrument invented by Mr. A. Claudet for measuring the intensity of the actinic radiations.

Photographometer. An automatic apparatus to record the angular position of objects situated around a given point.

Photographon. A complete portable photographic apparatus for field work.

Photographs. Pictures produced by the action of the sun's rays upon surfaces prepared with silver nitrate and other substances.

Photographs, Naturally Colored. (See *Heliochrome.*)

Photography. The art of producing pictures by the agency of light upon silver nitrate and other substances. Photography may be divided into three distinct parts, viz. I. *Photography upon the Silver Plate, or Daguerrotype.* II. *Photography upon Transparent Films or Substances.* III. *Photography upon Paper.* The theories and practical details of these various divisions will be found under appropriate headings in the different departments of this work. This article will be devoted to a *résumé* of the history of the art, which otherwise would not find place in a work of this kind. The several matters claiming attention under this head are so numerous that necessarily they must be treated briefly.

The idea of producing images by the agency of light upon argentic substances is not confined to the present century, as recent discoveries have developed the fact that attempts were made more than one hundred and fifty years ago by the savants of that period; and formulæ, of course of very little practical use, are said to have been published at that time on principles similar to those of the present day. It has also been stated that the jugglers of India were for many ages possessed of a secret process by which they were enabled to copy the likeness of an individual, and thus, as by means of other magic arts, impose upon the credulity and excite the fears of their followers. But this statement needs confirmation. Several philosophers, among them Theele, Petit, and Count Rumford, experimented upon the chemical properties of light and the peculiar changes effected by its agency upon the salts of silver. Ritter, Dr. Wollaston, Sir William Herschell, Sir Henry Eaglefield, and Sir Humphrey Davy pursued the investigation during the early part of the present century and added many interesting facts. The earliest recorded attempts at fixing the images of the camera obscura by the chemical influence of light were published by Mr. Wedgwood and Sir Humphrey Davy in 1802. These attempts were made upon paper and white leather, but failure to fix the impressions produced caused those gentlemen to abandon the idea, and it was not until M. Niépce directed his attention to the production of pictures by light in 1814 that the subject assumed any practical form. He pursued his investigations for ten years alone, and in 1827 he presented a paper on the subject to the Royal Society of London, keeping his process a secret. In the meantime M. Daguerre was pursuing investigations in the same direction, and having accomplished the fixing of the image produced in the camera, and M. Niépce hearing of the fact, proposed a copartnership, which was accepted and consummated in 1829. The early process of M. Niépce he termed *heliography*, and it was performed upon sheets of plated zinc, tin, copper, and on glass plates coated with *asphaltum* saturated with oil of lavender and heated over a hot iron. The employment of *iodine* and the polished silver plate is due to M. Daguerre, who in January, 1839, six years after the death of M. Niépce, published to the world the process by which the beautiful pictures now bearing his name were produced. Improvements in the daguerrotype were steadily made thenceforward until they were almost superseded by the photograph on paper. The use of *bromide* was introduced by M. Goddard in 1840, and during the same year M. Claudet applied the *chloride of iodine*. In 1834 Mr. Fox Talbot began experiments in the calotype (paper) process, and in February, 1839, published his first paper on the subject. This was the first successful attempt at producing positive photograph pictures upon paper. The discovery of hyposulphite of soda as a fixing agent has been claimed by several gentlemen. The final fixing of the daguerrotype by the chloride of gold was introduced by M. Fizeau. To Sir John Herschell we are indebted for several photographic processes upon paper, viz., cyanotype, chrysotype, and amphitype, as well as for the investigations of the photographic properties of the coloring matter of flowers. To Mr. Robert Hunt is due the discovery of the ferrotype and thermography, and to Dr. Woods that of the chrysotype, while Dr. Draper, of New York, introduced the lithotype. Several other photographic processes were discovered by M. Ponton, Dr. Schafhaentl, Mr. Fry, and others, which have been of more or less advantage to the art. In 1850 M. Niépce de St. Victor demonstrated the possibility of taking daguerrotypes in the natural colors and gave to his process the name of *heliochromanie*. M. Becquerel has also investigated the impressibility of the natural colors upon paper, and

has succeeded in producing several in all their brilliancy and beauty. Recently it has been announced that M. Victor has succeeded in fixing the colors on his plate, the only thing that has stood in the way of the practical application of his process.

This brings us down to the introduction of *albumen* upon glass as a vehicle for photographic negatives. Previous to this discovery paper had been used, waxed, to give it transparency, either before or after the application of the sensitive coating and exposure in the camera. In 1848 M. Niépce de St. Victor, of France, and Mr. J. A. Whipple, of the United States, simultaneously introduced this substance (albumen) to the photograpic world, and successively gelatine, serum, and other analogous substances were employed, and although the introduction of collodion by Mr. Archer two years later superseded it, nothing equals it for sharpness and beauty of detail of the negative picture. But the greatest stride in the progress of photography was made at the introduction of collodion. From that moment the art took a wider field, and to it we owe the beautiful gems that adorn the residences of the whole civilized world. The most important improvement in the positive paper process, *i. e.*, *toning* with chloride of gold before fixing or during fixing, was the invention of M. Le Gray, of France.

Important discoveries were made by Professors Wolcot, Draper, and Morse, and by Mr. J. Johnson. To these gentlemen we owe the first successful attempts in portraiture from life by the daguerrotype, and to Dr. Draper, who has constantly pursued the study of the art up to the present time, do we owe many valuable suggestions and improvements. To James A. Cutting the credit of having produced the most successful photolithographic process is due. An important point to every photographer in America should not be passed unnoticed, viz., Mr. Cutting's claims to the priority to the use of *bromine* in the collodion film or analogous substances. In 1849 Mr. Malone, of England, and M. Le Gray, of France, recommended its use, either as a bromide, chloride, or simply in the albumen film; and in January, 1850, Mr. Robert Bingham, of England, speaks of its use in collodion, while Mr. Archer, in his second published work on the collodion process, mentions fluoride or bromide of potassium as an ingredient of sensitized collodion. Mr. Archer's second pamphlet was published in March, 1852, several months anterior to the time claimed by Mr. Cutting. Bromides as accelerators of collodion are spoken of by several of the early writers on the collodion process.

For the optical improvements in photography we are indebted to Professor Petzval and M. Voigtländer, of Vienna; M. Chevallier, of Paris; Mr. Thomas Ross, of London; and Mr. C. C. Harrison, of New York. This brings history up to about a quarter of a century ago. Since then the useful men in photography could hardly be named in a work of this size. The interested historian may hunt them out. Their services are duly recognized and often named in these pages. (See CHRONOLOGICAL TABLE at the end of this work.)

Photography on Canvas. Portraits are produced upon canvas of any size in the enlarging cameras by any of the printing processes, after preparing the canvas by either of the following methods: Albumen may be prepared in the same manner as for paper and spread over the surface of the canvas; or solutions of gelatine, Iceland moss, or good white glue may be used, the latter being dissolved in acetic acid and then diluted to the required consistency with water; either of the last three are better than albumen, as they are not liable, if properly prepared, to crack after the picture is finished. Another method is to mix together some common whiting, kaolin, or chalk, in alcohol containing a very few drops of nitric or sulphuric acid; spread this over the canvas, let it stand a few minutes, and then wash it off clean with alcohol, and after drying, print by the "development process." Canvas may be also printed upon by the carbon process. (See INDEX.)

Photography on Paper. (See *Papyrograph; Photographic Printing*, etc.)

Photography on Wood. (Xylo-Photography). Photographing upon a wood block previously prepared for woodcuts. Substituting a photographic impression for a hand drawing on the wood block has the advantage of cheapness, rapidity, and exactness. (See *Photo-Xylography.*)

Photography of the Moon. (See *Lunar Photography.*)

Photogravure Process. A process for reproducing subjects in half-tone, in which the image, instead of being in relief, is

sunken in a copper plate. These plates cannot be printed in an ordinary press, but prints are obtained from them by "pulling," as in the process of printing steel engravings. Details of this process, which is somewhat complicated in practice, may be seen in Wilkinson's book on *Photogravure*.

Photo-Heliograph. An instrument invented by Mr. W. de la Rue for the production of accurate maps of the sun. It resembles something between the telescope and the photographic camera.

Photo-Heliotype. A photograph of the sun.

Photo-Lithography. The art of producing pictures by the combined agency of photography and lithography. A photographic copy is transferred to stone, and prints pulled from it in the lithographic press. These copies are either printed direct upon the stone under the respective negative—the surface of the stone having been made light-sensitive by asphaltum or bichromate—or upon transfer paper, then rolled up with thin fat printer's ink, soaked in water, which removes the soluble parts and adhering ink. The exposed portions of bichromate, with the firmly adhering fatty ink, remain upon the paper and are transferred upon the lithographic stone.

Photo-lithography is used for the reproduction of line subjects chiefly, but is capable of modification of application to half-tone reproduction. Husband's photo-lithographic process (papyrotint) is the method quite commonly used. Full details regarding this process are given in Wilkinson's *Photo-engraving, Photo-etching*, etc.

Photo-Lithophany (Photo-Filigrain). The production of photographic transparencies out of semi-transparent material (porcelain), the lights and shades of which depend on the greater or lesser thickness of the employed material. The photographic part in this process consists in the production of a swelled chrom-gelatine relief from a photographic negative, and a plaster-of-Paris cast from it. The rest is done by the porcelain worker.

Photo-Mechanical Printing in Half-Tone. The universal objection of typographic printers to half-tone plates, as usually produced, has prevented the general use of such blocks in many localities.

He is a skilled printer who can, with an ordinary job press and a pair of glue rollers, furnish even a passable proof from the ordinary shallow block. The zinc-etcher employing the Washington hand-press can produce a somewhat better result by careful rolling with stiff ink, but the pressure is direct, and hence faulty.

For many reasons a lithographic hand-press should be employed, because the "bite" obtained by the use of the roller and scraper, under the great pressure easily obtained upon the press, gives the finest results obtainable.

A good transferrer can produce upon the regular transfer-paper all the delicate half-tones of an etching upon copper or zinc, but this very delicacy and weakness precludes the use of such a transfer upon the stone, as it cannot be "put down" and etched strongly enough to admit of use upon a hand-press even, while for the wear and tear of the ponderous steam-machines of the present day, such a transfer would endure only a short time. An intaglio plate from a positive or transparency offers a happy solution of all difficulties. The lines are clear, sharp, and strong, and any workman skilled in pulling copper-plate engraving transfers, such as cards, invitations, etc., will have no trouble with a well-bitten intaglio. The plate must be slightly warmed, the lines cleared from all substances, and surface cleared by a little whiting finely prepared rubbed *across* the lines, not with them. When the "original" is once upon the stone, it may be slightly warmed and set aside in a covered box for a few hours until well set, when it may be gummed, fanned dry, and proceeded with as an ordinary original.

Now the advantages arising from the substitution of the lithographic hand-press are many. Multi-color work is easily executed, as registration is readily attended to (a bugbear to all type-printers), while the expense of electros is obviated. The work can be handled in sheets instead of one picture at a time, and the colors run in perfect purity, which is not the case with electros. No pure reds, so all-important in any picture, can be got from copper-faced blocks, unless the same be first silver- or nickel-plated, which causes delay and expense. Any photo-engraver who would like to increase his business and build up a reputation for good work, can introduce color designs for labels and show-cards, book-covers, etc., and reap the reward.

Landscapes can be run in five, eight, or twelve colors, with excellent effect. A scheme for an eight-color picture may be made up—No. 1, yellow; No. 2, red; No. 3, light blue; No. 4, light red; No. 5, dark blue; No. 6, light brown; No. 7, dark brown; No. 8, gray.

The artist in water-color will readily lay on these tints as needed to secure proper effect.

A scheme in ten colors may be as follows: No. 1, lemon yellow; No. 2, flesh or buff; No. 3, green; No. 4, red; No. 5, light blue; No. 6, light red; No. 7, light gray; No. 8, dark blue; No. 9, light brown; No. 10, dark brown.

In these schemes the black block or stone is only used for the customary "set offs." It is not to appear in the finished picture. A good portrait scheme in seven colors may be as follows: No. 1, yellow; No. 2, deep flesh; No. 3, crimson; No. 4, blue gray; No. 5, dark gray; No. 6, dark brown; No. 7, deep brown.

The photo-mechanical papers now sold in great variety by Weber & Co., of Philadelphia, and Devoe, Reynolds & Co., of New York, offer fine effects when used with lithographic crayons, and beautiful color effects are readily produced by the artistic workman at a tithe of the expense incurred by the usual stone methods. Ornamental lettering needs no reversal, and can easily be done with the draughtsman's instruments. Autographic circulars are readily produced. Of course it is known to all color printers that green, purple, and orange may be produced by superimposed colors, thus saving a special run and much expense. Charming tertiary effects in citron, russet, olive, and gray are easily secured in this manner. If there are figures or buildings in the picture we may need a warm or sunny tint over the whole, a purple over some portions with two yellows, three blues, three reds, a green, two grays, and two browns, say fifteen colors or printings. This is for work of very high class only. Granulation in the color effects, so highly important, is readily secured by the use of these papers.—*C. Ashleigh Snow.*

Photo-Mechanical Processes. Such processes as—by the aid of photography—admit of the production of printing-blocks, from which large numbers of impressions may be made in the printing-press, for instance, autotypy, photochemigraphy, etc. (See INDEX.)

Photometer. An instrument devised to measure the visual intensity of light. This name is often erroneously applied to instruments used to determine the exposures required by sensitive surfaces in photography, but as these depend upon the chemical and not the visual light rays, it is obvious that the title is a misnomer.

I. The photometer constructed by J. Fleury Hermagis consists of a simple prism made of yellow glass (Fig. 157). Upon the inner surface thereof lines are drawn from

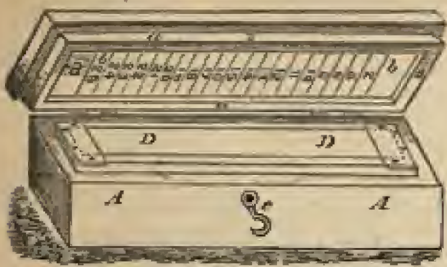
FIG. 157.

1 up to 10—No. 1 representing the finest part of the prism, No. 10 the thickest. A piece of sensitized paper is introduced under the prisms and allowed to remain one minute; according to the number that the impression has reached, it is easy to calculate the photogenic power of the light. The diagram gives the size used by the inventor.

II. The photometer invented by Dr. H. W. Vogel consists of a box, *A A* (Fig. 158), provided with a lid, *B B*, as shown in the drawing. The lid consists of a frame, *a*, by which a glass plate, *b*, is held; on the upper side of this glass plate is secured a series of thin strips of paper, which are arranged mathematically in layers, each lower layer projecting like steps beyond the layer above. This step system thus produced represents semi-transparent media, the transparency of which decreases by degrees toward the thicker end. Black figures upon the under side of the lower strip indicate the number of layers

arranged above each such figure. The whole cover, with the paper system in it, can be folded down and fastened by the small hook, *c*, and is provided with a second cover of

FIG. 158.



wood to protect the glass from injury when not in use, and to make and close the exposure. Within the box is a sliding false bottom, *D*, which is, by means of a steel spring, pressed upward against the scale described above, when the lid is closed. Upon this false bottom a number of strips of paper are placed, which have been sensitized by immersion in a saturated solution of bichromate of potasium, of 1 ounce bichromate to 30 ounces of water. In order to get these in place, the bottom of the box is opened, the spring removed, and the false bottom taken out (it may be used as a guide to cut the strips of sensitized paper), the strips placed in the box, the false bottom dropped in upon them, and the bottom closed; the photometer is now ready for use. This must be done in the dark-room, and the figures should be kept dry. Strips sensitized in this way will keep for a month. It will now be seen, when the apparatus is exposed to light, that the sensitized strip changes in color in proportion to the amount of light it receives, the most light passing through the spot marked 2, the next 4, the next 6, and so on, and the change will be rapid or slow according to the intensity of the chemical action of the light. Since the introduction of this one there have been many other photometers devised and sold by dealers.

Photo-Micrography. The process of obtaining enlarged images of microscopic subjects by a combination of microscope and photographic camera is called photo-micrography. This work is an important branch of medical photography, but is too complicated in manipulation to be treated here in detail. The reader is referred to the excellent work upon *Photo-micrography*, written recently by Mr. Andrew Pringle, where full instructions may be obtained, and to *Wilson's Photographic Magazine* for 1894. The Bausch & Lomb Optical Co., Rochester, N. Y., give much information in their catalogue. (Not to be mistaken for *micro-photography*—which see.)

Photo-Peripatetigraph. An invention for the use of outdoor photographers, con-

FIG. 159.

sisting of a dark-room on wheels, furnished inside for the purpose named. Designed by R. Goebel.

Photophane. A process employed in Europe, by which glazed collotype prints, very similar in appearance to burnished albumen prints, are produced.

Photophone. An apparatus devised by Alexander Graham Bell for the production and reproduction of sound by means of the undulations of light. Vibrations are reconveyed between distinctly separated diaphragms by a beam of light. These beams are now photographed.

Photo-Phosphorescence. The peculiar property which some bodies possess of shining in the dark, influenced solely by ray-producing power of light, and imparting luminous photogenic action in the dark, is termed photo-phosphorescence.

Photo-Sculpture. The application of photography for the representation—true to Nature—of busts or clay models. Twenty-four small negatives are made from the model from different points of view; these, by a powerful light-source, are projected on an enlarged scale on a transparent screen, and the contours of this enlarged picture transferred upon a block of clay by means of a pantograph for the sculptor's use.

Photo-Plastigraphy is a simplified method of the above. The original method was invented by Mons. François Willème, a distinguished Belgian sculptor. Mr. T. Cummings, Lancaster, Pa., Mr. Wm. Kurtz, New York, and others have made improvements in photo-sculpture, but its difficulties have rendered it unavailable for popular use.

Photospires. Simple arrangement for burning magnesium powder, consisting of bent glass pipes.

Phototel. An instrument proposed by R. Ed. Liesegang for the transmission of the lens picture by an electric current.

Photo-Theodolite. Theodolite camera; an instrument for photogrammetric pictures or plans, consisting of a surveying theodolite in connection with a camera. The latter is of metal, without bellows, consequently of fixed view distance. The instrument has also a graded metal circle, horizontally adjustable, upon which the camera rests during exposure, and a telescope for focussing. The whole is fixed upon a tripod.

Phototint Process. This name is given to a process in which collotype prints are transferred to stone and printed from in a lithographic press.

Also, a process devised by Mr. Cocking, an English amateur, in which prints were made from two negatives of a subject, one being an ordinary photographic negative, the other prepared by hand. By this latter process, prints were obtained in which certain effects of light and shade not in the photographic negative were apparent, with advantage to the finished print.

Photo-Typographic. Pertaining to the processes which, by the aid of photography, make the production of etched clichés printable in a book-printing press possible. (See *Autotypy; Photochemigraphy; Photo-Galvanography*, etc.)

Photo-Typography. A process of making zinc blocks or clichés or cuts, printable in a book-printing press, from photographic half-tone negatives from objects in Nature, pen-drawings, washes, or paintings. The half-tone gradation is effected by the interposition of a line or grain screen between the sensitive plate and the subject to be copied. It is of great importance in book and newspaper illustration.

Photo-Vitrified Enamels. (See *Enamel; Burnt-in Enamel*, etc.)

Phototype. A modification of the collotype process, in which the gelatine film itself is printed from. (See INDEX.)

Photo-Xylography. The art of printing photographic impressions upon wood blocks for engraving purposes. Several methods have been devised for this purpose, the most practical of which are:

I. M. Contencin floods the surface of the wood with varnish two or three times, until it ceases to absorb the liquid, but allowing no coating on the surface, the object being simply to saturate the fibre; this effected, the block is placed aside to dry. Next proceed to coat the face with a white preparation; for which purpose use washed chalk or whiting, or zinc white, which answers the purpose better, applying it with a flat camel's-hair brush, the excess being swept off. When this is dry, the surface is again covered with varnish, and all not immediately absorbed is allowed to drain off, the wood being placed on edge; this last operation lowers the color of the white coating, but it still remains sufficiently opaque to observe the grain of the wood. A solution of gelatine, 12 grains to 1 ounce of water, with 20 grains of chloride of sodium, is then poured over the white preparation and allowed to drain off at the lower edge; too thin a film must not be used, or it will not darken sufficiently under the negative. The block is rendered sensitive by being placed, face downward, in a glass tray containing a solution of nitrate of silver, 70 or 80 grains to the ounce of water, and kept carefully from contact with the bottom of the dish by slips of glass; in this manner but a small quantity of sensitizing solution is needed. To print, make use of the ordinary pressure-frame without the back, adjusting the block and negative in a way to allow of their being removed and replaced if necessary. Tone in a gold bath and fix in hyposulphite of soda the same as for paper, and wash under a stream of water.

II. Mr. Barnard's process: 1st, Take a collodion positive upon glass; 2d, coat the

block of wood with lamp-black mixed with gum-water; 3d, transfer the positive to the block in the following manner: Lay a piece of wet blotting-paper upon the collodion film, leaving one edge of it uncovered; turn that edge over the blotting-paper with a penknife; remove the blotting-paper with the film adhering to it from the plate and apply it to the wood block; press the two into due contact, and remove the blotting-paper, leaving the positive adhering to the blackened block; stand aside to dry.

III. By the carbon process: Prepare the wood as usual by covering the face with some white pigment ground with alcohol or gum-water. Make a print on paper by the carbon process; moisten the print with an alcoholic solution of caustic potash, and lay it immediately, face downward, on the whitened surface of the wood block; then lay a piece of cardboard upon the back of the print, and place it under pressure, or rub it vigorously for a minute or two with a paper-knife or burnisher; on removing the cardboard the design will be found transferred to the block.

IV. Mr. Robbins' process: Hold the polished block to the fire till quite hot; then rub it with beeswax till there is a smooth, even coat. Hold it again before the fire till the wax runs; then put it in a cool place to dry. Coat the waxed block with collodion in the usual way. Excite in the nitrate bath by floating; print from a negative, or take a negative on the wood in the camera; develop in the usual way and wash thoroughly; no fixing in needed.

V. Lallemand's process: The wood block is first placed with its surface on a solution of alum, and is then dried; it then receives a coating composed of animal soap, gelatine, and alum on all its faces, put on with a brush; when the coating is dry, the surface which is to receive the picture is placed for some minutes in a solution of muriate of ammonia, then dried; then a bath of nitrate of silver of 20 per cent., and dried. It is then placed under the negative and printed, fixed in a saturated solution of hyposulphite of soda—a few minutes is enough—and washed for five minutes, and then dried.

Photo-Zincography (Zincography). The transfer of a photographic picture on zinc (either by direct print on the sensitized zinc plate or by transfer-paper) for impressions in the lithographic press by fatty colors (See *Photo-Lithography.*)

Photo-Zincography. The art of engraving upon zinc by the aid of photography. The process is similar to the photo-lithographic process of M. Asur. A sheet of paper is first coated with a solution of bichromate of potasium and gum; then dried and exposed under a negative highly intensified. It is then perfectly and evenly covered with lithographic ink by passing it through a press on a zinc plate covered with the ink. After this is done the paper is turned over on a plate of glass, and the back of it moistened with gum and water, which, passing through the paper, dissolves the gum and soluble portion of the bichromate to which the ink adheres, whilst it does not affect the insoluble portion on which the lines and letters are. The hold of the ink to the blank parts of the drawing or writing having thus been destroyed, its removal is effected by again passing the paper through the press on a plate of zinc charged with ink. This second coat of ink, adhering to the ink on the whole surface of the paper, brings away with it all that was on the blank parts, whilst at the same time it leaves a second charge of ink on the lines or letters. For the transfer to zinc the anastatic process is used; and so perfectly charged are the lines and letters with ink, that two or even three or four plates can be produced from the same photograph.

For the transfer of these photographs to the waxed surface of a copper plate, it is necessary that the paper should be transparent, in order that, before rubbing it down, the reduced drawing should be accurately adjusted to the marginal lines and trigonometrical points, which have been previously laid down on the copper plate, and thus obviate the possibility of any distortion. This process is the early one of its class, and has been greatly modified and improved. (See Index.)

Photozone. An instrument designed by Dr. R. M. Smith for instantaneously exposing and closing the camera.

Phozometer. (See *Focimeter.*)

Picture-Printing. To print pictorially. The lamented photographic artist, O. G. Rejlander, once remarked: "I have a lively presentiment that the time will come when a work will be judged by its merits, and not by the method of its production." It is too

commonly the custom to relegate photograph-printing to the hands of the youngest and least capable of the employés. The pictorial quality of the print is not entirely decided during the exposure of the plate upon a well-selected view, and during the development of the negative; much may be done to secure a beautiful picture during the printing, provided the plate was *focussed pictorially*. Few pay this art proper attention. In an artistic photograph the object upon which the attention should be fixed must stand out prominently in the print—the eye should rest upon it, undistracted by other parts. Thus sweeps of shade may lead up to a more highly lighted portion where the principal object may be located, or a sweep of light may lead the eye to a prominent dark object.

An operator whose taste has been pictorially cultivated may, by proper masking, secure this much-to-be-desired effect. One may give atmospheric effect to the distance. Foliage may be gradated, and foreground corners improved. Tissue-paper carefully stretched upon the back and manipulated properly with the stump will be found powerful aids. A suitably perforated card can be moved to and fro, allowing the light to impinge upon portions of the negative where strength is needed. The most favorable effect can be secured when the sunlight falls across the picture, not coming from behind or fronting the camera. When the masking and vignetting are properly attended to, a thin sheet of celluloid can be fastened to the front of the frame by metallic buttons and the printing allowed to go on until the needed depth is secured. For pure whites and unfading quality always use two hypo baths, and fix in very subdued light. The hypo bath should be slightly alkaline.

Raising the lens-board cuts off the too frequently out-of-proportion foreground—*i. e.*, the object of interest must be that most sharply defined upon the ground-glass when focussing; the sweeps of light and shade may be secured in the printing. A card of black Bristol dull-surface board may be perforated slightly smaller than the cap of the lens, and slit with seissors into fine fringe. During the exposure, which should be upon a slow plate, this card can be slowly passed two and fro before the lens—never encroaching, however, upon the centre of the field.

A properly vignetted photograph is a beautiful thing. This effect can be still further secured by dabbing the glass side of the negative with Gihon's opaque mixed with a bit of sugar candy and moistened with water. Let it be solid at the extreme corners, of medium density near the same, and fade lightly away at the edges. The general shape is an ellipse.

Remember the golden rule: Expose for the shadows; that is, the detail in the shadows must be developable, or no artistic picture can be secured. A good gradation can be further had by inserting a large diaphragm upon which a bit of writing-paper is gummed, perforated with an aperture the size of the stop intended to use, while about the aperture small holes may be pierced with a darning-needle in irregular order. A picture full of strong contrasts may be harmonized by sweeping a strong developer across the plate, carrying away the free silver, while a weak developer confined to the surface will increase contrast where little exists.—*C. Ashleigh Snow.*

Pigment Printing. Autotype process; carbon printing; a process of producing photographic prints on paper by means of bichromate salts and a gelatine film, colored with lamp-black, charcoal, or other pigment. Such carbon paper is floated on a solution of bichromate of potash or ammonia, dried in the dark, exposed under a negative, soaked in water on its support, developed in warm water, hardened in an alum bath, and finally washed and dried.

Pigment Process. The pigment or carbon process depends upon the property which gelatine has of losing its solubility in hot water on exposure to light in the presence of chromium salts. If a paper coated with gelatine containing any desired pigment or coloring matter is made sensitive to light by immersion in a solution of bichromate of potash, and exposed to light, the parts acted upon by light remain unchanged when the picture is treated with hot water, and a positive picture results. This process is utilized for the production of direct prints upon all kinds of surfaces and in the photo-mechanical processes. (See *Carbon Process.*)

Pine-Soot. Lamp-black; a black soot obtained from resinous wood; pitch-wood. Used in the carbon process, and for black paint (with alcohol and gum).

Pin-Holes. Small, transparent spots in the sensitive film, usually caused by dust which

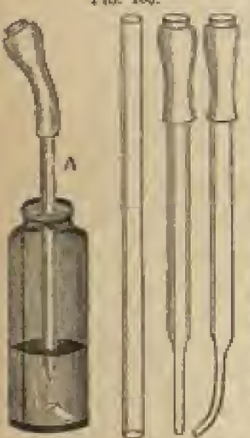
settles on it during the preparation or during the exposure.

Pin-Hole Camera. A camera without objective. In place of the latter a very fine opening is used. Pictures made with it are not very sharp, but free from distortion, and the picture angle (up to 120°) is so large that very near exposures of high and broad objects can be made with it. The exposure, however, has to be long, as compared to that when an objective is used.

Pin-Hole Photography. The possibility of obtaining photographic pictures without a lens has long been a subject of interest, and has recently been abundantly verified in fact. For this purpose a light-tight box, in which at one end a thin metal plate pierced with a minute hole is inserted, is sufficient for an experiment. The sensitive plate or paper is inserted in a vertical position at the end of the box opposite the pinhole. To expose the picture the pinhole is uncovered, and a protracted exposure is given. The image thus obtained is always fairly sharp, depending for definition upon the size of the pin-hole. The angle of view included and the size of the image depends upon the size of the plate and its distance from the pin-hole.

Pipette. By using pipettes the photographer can take from any solution desired, drop by drop. They are five or six inches in length and about three-eighths of an inch in diameter. They can be readily made by the photographer from glass tubes, and with pieces of rubber tubing and a few corks. The points are made by heating the piece of glass tube in the middle, turning as the heat increases. When it has become soft and pliable pull suddenly and cause the separated parts to be drawn out into very fine points. Breaking off one of these points will secure a tube with a fine aperture.

Fig. 160.



Pistolograph. A peculiarly constructed pocket camera, working with a spring, for taking small instantaneous views.

Pizzighelli's Direct Plantinotype Process. According to the latest method published by Captain Pizzighelli, the originator of this beautiful process, suitable photographic paper is first impregnated with a resinous solution obtained by mixing 1 part of gum dammar in 100 parts of alcohol. This closes up the pores of the paper and prepares it for being sensitized.

With regard to the sensitizing solutions, the new formula for the *sensitive mixture, for arrowroot or resin paper*, is the following:

Stock Solutions.

A.	Potassium Chloro-platinite	10 grammes.
	Distilled Water . . .	60 c.c.
B.	Ammonium Ferric Oxalate	40 grammes.
	Potassium Oxalate Solution (5 per cent.) . . .	100 c.c.
	Glycerine	3 "
C.	Iron Solution B . . .	100 "
	Potassium Chlorate Solution (1 : 20) . . .	8 "
D.	Mercuric Chloride Solution (5 per cent.) . . .	20 "
	Potassium Oxalate Solution (5 per cent.) . . .	40 "
	Glycerine	2 "

As to the preparation of solution B, the potassium oxalate should be heated up to about 40° C., and the ammonium ferric oxalate dissolved in it. Upon cooling, some ammonium oxalate will be precipitated; the clear solution should then be filtered off, and kept in the dark. In order to prevent the formation of mould, a drop of carbolic acid should be added to the liquid.

For sensitizing a sheet (demy size) when black tones are desirable, and if negatives of medium density are used, we must take:

Solution A	5 c.c.
Solution B	6 "
Solution C	2 "

For harder negatives the quantity of solution C should be diminished or entirely omitted, and solution B increased to the same extent; in the case of softer negatives the reverse is to be adopted.

The printing process with these papers is generally familiar. The action of light should go on until the print shows the intensity it should have when finished. The time of printing may, however, be shortened if, after the deepest shadows have appeared, the prints are developed cold. For this

purpose either the 5 per cent. potassium oxalate solution may be used or a 5 per cent. aqueous solution of washing soda.

The printing being completed, the pictures are fixed in a bath of hydrochloric acid 10 parts, water 800 parts, which is changed two or three times.

The bath may, however, be replaced by the following one, recommended by A. Huszar:

Sulphate of Copper . . .	10 grammes.
Water	1000 c.c.

which is employed in the same manner as the hydrochloric acid bath. Finally, the prints are washed in ordinary water and dried. (See *Platinotype.*)

Place at Point. To place the camera at the point is to lengthen or shorten it until the image attains its maximum clearness upon the ground-glass.

Plain Collodion. Pyroxylin simply dissolved in alcohol and ether without the admixture of the sensitizers.

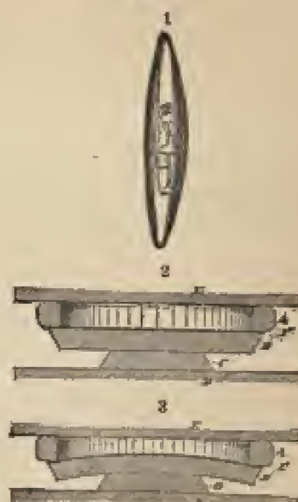
Plain Paper. Raw paper; the finest of all papers; faultless as to purity, closeness, sizing, and uniformity of its surface. Used after sensitization on the silver bath or coating with emulsion, for the production of prints according to the different printing processes.

Plain Photographs. This term is applied to all photographs upon plain salted paper and to those untouched by the artist's pencil.

Plain Salted Paper. A term applied to all papers salted as they come from the mill, to distinguish them from those prepared with albumen, gelatine, etc.

Plaque Photography. A method invented by F. B. Clench, which has for its object to produce a means by which to press photographic pictures so as to assume a concave shape and to imitate in appearance the porcelain plaque. It consists of the novel devices and combination devices here described. In the accompanying drawings (Fig. 161), 1 represents a perspective view of a picture as produced by this device; 2, a cross section of the dies as placed together and before being compressed, and 3 a similar view of the dies after compression. Corresponding letters in the several figures of the drawings designate like parts. The frame *A*, rubber plate *B*, extended across said frame *A*, and central rubber block *C*, when used in combination with any common press, substantially set forth, is the claim made in Mr. Clench's patent.

FIG. 161.



Plaster Casts from Transparencies. It is sometimes desirable to convert a photograph into a plaster plaque, which may be mounted on a tablet for exhibition. This may be done by making a transparency of the subject, and after fixing (alum not having been used) and washing, the plate is subjected to heat, which renders the image in relief. If the transparency is made by the bichromated gelatine process the relief will be more strongly marked than with an ordinary gelatine plate. While the relief is moist and at its best, pour on No. 1 ordinary plaster as used in casting, mixed with a little alum to harden it. When dry the plaster will leave the gelatine without trouble, giving an accurate and beautiful casting.

Plate. The tablet upon which the photographic image is produced.

Plate-Block. An instrument upon which to secure the daguerrotype plate during the operation of cleaning.

Plate-Changing Arrangement. A contrivance in detective cameras for substituting fresh for exposed plates, consisting either of a magazine above the camera, from which plate after plate is moved into posi-

tion automatically, or of two magazines with space for the objective between, the plates being brought successively into position for exposure from the upper magazine into the middle space, and, after exposure, into the lower magazine; sometimes also it consists of a leather bag, within which the exposed plate is moved up with the fingers and behind the last of the contained plates.

Plate-Holder. This term is applied almost indefinitely to everything upon or into which the plate is placed.

Plate-Shield. The black frame inclosing the daguerrotype plate, or photogenic paper, film or glass, during its exposition to light in the camera. The camera box usually contains a separate shield for each size of plate.

Plate-Vice, or Buffer. An instrument for holding the plate while being buffed or cleaned.

Plate-Washer (Washing-Rack). A box-like receptacle with notches for the reception of negatives during the washing under the tap, the water running out through a pipe in the lower part, the plates being so arranged as to be continually under water. The box is usually supplied with a removable rack for the plates, on which they are lifted out and left to dry.

Platinotype. A photographic process discovered by Sir John Herschell, and based upon the changes effected by light upon the chloride of platinum. In 1878 Mr. W. Willis patented in England an original process for obtaining prints in platinum, to which was given the name of platinotype. This process, which is based on the reduction by the action of light of ferric oxalate into ferrous oxalate, and the further reduction of a platinum salt by the ferrous oxalate to the metallic state when developed by the aid of a suitable agent, being a patented process, cannot be given here. The right to use it may, however, be obtained at a trifling cost from the patentee; by it beautiful prints in black and white or sepia may be obtained with ease and certainty. The prints thus obtained are undoubtedly permanent. Prints precisely similar to those obtained by the Willis process may be had by employing Pizzighelli's platinotype process given elsewhere.

Platinotype Paper. Paper prepared with iron and platinum salts for printing from negatives. It can be prepared both for printing-out and printing with subsequent development. (See *Platinotype.*) It gives matt pictures resembling copper engravings.

Platinum. This metal is always found in a native alloy with osmium, iridium, rhodium, and palladium. It occurs in alluvial deposits, often with gold, in small flattened gray grains. The chief source of platinum is at Nischni-Taglisk, in the Urals, but it is also found in South America, California, and Borneo. Platinum tetrachloride (commonly but erroneously termed bichloride) is used for toning collodion positives, and should be used dilute, and at a temperature of about 70° F. It frequently contains excess of hydrochloric acid, which should be carefully neutralized with *carbonate of soda* (*not* potash or ammonia), and then made slightly acid with nitric acid. The tetrachloride of platinum is also a ready solvent for silver chloride, and the latter can be *crystallized* from this solution. Chloro-platinite of potassium is used in conjunction with a *ferric* salt for preparing platinum paper, as in contact with ferrous oxalate it is at once reduced. This salt is also used for toning silver prints, and gives the best results with a matt-surface print. The method is as follows: A 60-grain tube of the salt is dissolved in 2 ounces of distilled water (and should completely dissolve, leaving no yellow sediment of potassium chloro-platinite). This forms the stock solution of 30 grains to the 1 ounce, or 1 grain in every 16 minims. For use, take 16 minims, add a drop or two of nitric acid, and make up to 1 ounce with water. Now, having washed the matt-surface prints in two or three changes of water, with a brush swab each print with the platinum solution, and in about one minute toning will be complete. Then place the prints in water in which a small quantity of carbonate of soda has been dissolved, then fix and wash as usual.

Platinum-Black. Platinum as a finely divided black powder. Used in spectral photography, in Geissler pipes, for the removal of quicksilver fumes.

Platinum Toning. If prints—albumen, salted, or chloride, or silver gelatine, or collodio-chloride paper—are placed in a dilute solution of chloro-platinite of potash the silver image is converted into a platinum image. This method is largely used as a substitute for gold toning, the tones obtained being of a pleasing color, and more perma-

nent. Plain salted paper is especially adapted to this method. The printing operations up to the toning are exactly similar to those employed in albumen printing.

W. K. Burton finds that prints on almost any kind of paper can be readily and satisfactorily toned with platinum if citric acid be employed instead of the usual nitric and the prints placed in a weak solution of ammonia when removed from the toning bath. The fixing solution should also have sufficient solution of ammonia added to make it perceptible.

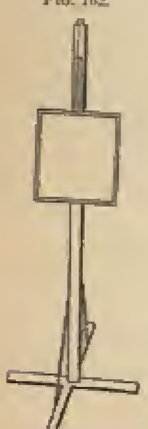
Where a number of prints are to be toned at one time the platinum salt may be reduced to a half or even a quarter. The prints should be placed in the solution without preliminary washing.

Potassium Chloro-platinite	2 grains.
Acid Citric	5 "
Sodium Chloride (common salt)	8 "
Water	1 ounce.

This solution will keep indefinitely, only requiring occasionally to be reinforced by small additions of the platinum salt.

Platino-Uranotypy. A printing process with subsequent development. The paper for this purpose is prepared with a mixture of equal parts of concentrated chloride of uranium and platinic chloride of potash solution (1:12), developed cold in concentrated solution of oxalate of potash, saturated with ferrous oxalate. The picture is printed till fairly visible.

FIG. 162.



Plumbago Process. (See *Ceramic* and *Dusting-on Processes.*)

Pneumatic Holder. Pneumatic plate-holder. An instrument usually made of wood with rubber plate and brass screws, for holding glass plates during cleaning, varnishing, coating, etc.

Point of Sight. (Fig. 162.) Made with a standard six feet high and with the feet twenty inches long. At the top and bottom of the standard is a quarter-inch hole with a string passing through each and tied. A cabinet card fastened upon the string may be easily moved up and down to any point.

Poisons and Antidotes, Elsden's Table of. (From the *News Year-book.*) See Table on page 294.

Poitevin's Carbon Process. This method is based on the remarkable property possessed by a mixture of perchloride of iron and tartaric acid. Superseded by modern processes.

Poitevin's Printing Process. By this process the finished proof is a picture in *gallate of iron*, or ordinary writing-ink. Obsolete.

Polishing. (See *Buffing the Plate.*)

Polishing-Wheel. (See *Buffing-Wheel.*)

Polythionates. Salts formed by the union of the polythionic acids with the bases.

Porcelain Dippers. Dippers made of porcelain.

Porcelain Dishes. Shallow vessels made of porcelain to hold photographic solutions.

Porcelain Photography. The production of photographic images on slabs or vessels of porcelain which may be permanently fixed by burning them in with ceramic colors. This process is the invention of P. L. N. Foster, Esq., V. P. The plate or vessel of porcelain on which the pictures are to be produced, may be glazed prior to the application of the sensitive mixture, or otherwise this glaze or flux may be carried over the picture before burning. The first preparation of the plates after cleaning consists in the application of the following mixture. Make separate solutions of gum-arabic and gelatine: gum-arabic, 72 grains; saturated solution of bichromate of potash, ½ ounce by measure; dissolve without heat. Gelatine, 15 grains; water, 1 ounce, by measure; saturated solution of bichromate of potash, 1 drachm, by measure; dissolve in water-bath; when cool add the bichromate; shake well and filter. Take of the solution of

Gum-Arabic	11 parts.
Gelatine	5 "
Distilled Water	5 "

To every drachm of this mixture add 9 or 10 drops of honey syrup, formed by mixing equal parts in volume of honey and water, and filtering. This mixture must be heated gently in a water-bath, well shaken, and filtered through fine muslin. The porcelain is slightly warmed, and a sufficient quantity of this sensitive mixture poured on, in the same manner as collodion, drained off, and gradually dried before a fire. The film must be very even. A vigorous positive

Elsden's Table of Poisons and Antidotes.

(From the *News Year-book.*)

Poisons.		Remarks.	Characteristic symptoms.	Antidote.
Vegetable Acids.	Oxalic Acid, including Potassium Oxalate.	One drachm is the smallest fatal dose known.	Hot burning sensation in throat and stomach; vomiting, cramps, and numbness.	Chalk, whiting, or magnesia suspended in water. Plaster or mortar can be used in emergency.
Caustic Alkalies.	Ammonia . . . Potash . . . . Soda	Vapor of ammonia may cause inflammation of the lungs.	Swelling of tongue, mouth, and fauces; often followed by stricture of the œsophagus.	Vinegar and water.
Metallic Salts.	Mercuric Chloride	Three grains the smallest known fatal dose.	Acrid, metallic taste; constriction and burning in throat and stomach, followed by nausea and vomiting.	White and yolk of raw eggs with milk. In emergency, flour paste may be used.
	Acetate of Lead .	The subacetate is still more poisonous.	Constriction in the throat and at pit of stomach; crampy pains and stiffness of abdomen; blue line round the gums.	Sulphates of soda or magnesia. Emetic of sulphate of zinc.
	Cyanide of Potassium.	*a.* Taken internally, three grains fatal.	Insensibility, slow gasping respiration, dilated pupils, and spasmodic closure of the jaws.	No certain remedy; cold affusion over the head and neck most efficacious.
		b. Applied to wounds and abrasions of the skin.	Smarting sensation.	Sulphate of iron should be applied immediately.
	Bichromate of Potassium.	*a.* Taken internally.	Irritant pain in stomach, and vomiting.	Emetics and magnesia, or chalk.
		b. Applied to slight abrasions of the skin.	Produces troublesome sores and ulcers.	
	Nitrate of Silver .	....	Powerful irritant.	Common salt to be given immediately, followed by emetics.
Concentrated Mineral Acids.	Nitric Acid . . .	Two drachms have been fatal; inhalation of the fumes has also been fatal.	Corrosion of windpipe, and violent inflammation.	Bicarbonate of soda, or carbonate of magnesia or chalk; plaster of the apartment beaten up in water.
	Hydrochloric Acid	Half an ounce has caused death.		
	Sulphuric Acid .	One drachm has been fatal.		
Acetic Acid		Concentrated, has as powerful an effect as the mineral acids.		
Iodine		Variable in its action; three grains have been fatal.	Acrid taste, tightness about the throat, vomiting.	Vomiting should be encouraged, and gruel, arrowroot, and starch given freely.
Ether		When inhaled.	Effects similar to chloroform.	Cold affusion and artificial respiration.
Pyrogallol		Two grains sufficient to kill a dog.	Resemble phosphorus poisoning.	No certain remedy. Speedy emetic desirable.

picture, either from a collodion negative, paper, or albumen, or even an engraving, must be placed in contact with the sensitive coating, and the while exposed to light—sunlight if possible. The amount of exposure is of great importance; from six to ten minutes in good sunshine is in most cases sufficient. When removed from the light, a negative image should be visible, the action of light darkening and hardening the sensitive layer to a much greater degree when using the above mixture than when using plain gelatine. The sunned parts are darker, and the unsunned parts softer, than is the case with gelatine alone; the advantage taken of this hardening effect of light on the film will be apparent in the next stage of the process.

To produce the positive image in ceramic color, carry over the surface of the plate the color, in a fine state of division, by means of a pad of cotton-wool, well charged with the required color. Its successful application requires some experience. The surface should be beaten gently and equally, not rubbed. The cotton should be occasionally breathed on, and re-charged with color. The color will be found gradually to adhere to the unsunned parts of the film, and its application should be continued until the picture is considered sufficiently powerful. Almost any amount of vigor may be obtained. The picture is produced by the parts not exposed to the light taking the color, and those portions exposed refusing to take it. The original negative image will now be almost lost to appearance by the superior density of the applied color, forming the positive picture; but there remains in the sensitive coating the changed and unchanged bichromate, which it is necessary to remove. To effect this, apply alcohol to which has been added dilute acid in the proportion of 6 drops of the dilute acid to a drachm of alcohol. The dilute acid contains 5 grains ordinary nitric acid to the drachm of water. A bath of this may be used, or, if the subject is on a flat surface, it may be poured on. While on the plate evaporation of the alcohol takes place; this would be equivalent to adding too much dilute nitric acid to the alcohol, which would damage the film; therefore, in pouring on and off the liquid, care must be taken to keep up the proportion by adding a little pure alcohol occasionally. When the brown color of the changed bichromate disappears, the acid spirit must be poured off, and pure alcohol poured on and off; this must be repeated once or twice with fresh quantities, it being necessary to remove every trace of the acid and water. The picture must be dried very rapidly, and is now ready for burning, provided the recipient has been covered with a flux or glaze; if not, the flux may be applied over the picture in the following manner: Pour on a solution of Canada balsam in spirits of turpentine. Dry the plate by heat until the turpentine is entirely evaporated. Prepare the flux, which may consist of borax and glass, or borax, glass, and lead, by grinding it on a slab, and drying. Apply this equally and evenly, by means of a pad of cotton tied up in soft and very flexible leather. With respect to the colors used, they are ground on a slab with water and dried. Glass, ordinary kelp or opal glass, may be used instead of porcelain. The burning-in is effected in the muffle-furnace. (See *Photographic Enamelling*.)

Porcelain Pictures. Photographs upon opal glass, whether by the collodion or carbon transfer, gelatino-bromide, gelatino- or collodio-chloride processes, are sometimes called porcelain pictures. The simplest way to produce such pictures is to make a print, in any desired color, by the carbon process, and transfer it to the opal surface.

Portable Camera. A light folding camera, easily transported.

Portable Camera-Stand. A light, folding, easily carried tripod for the camera. Its legs are of two to four pieces, made to slide. A head, round or triangular, of wood or brass, upon which the camera is screwed, holds the legs together.

Portrait Lens. A double objective of great rapidity or light-force, admitting of being worked with comparatively large opening (up to one-third of its focal length). It is not, however, free from distortion, gives a round view-field, and has but little depth of focus. Used almost exclusively indoors and for projections.

Portraiture. Although portraiture is practicable in the open air or in an ordinary room, yet the best results can be obtained only in a room suitably lighted by a sky or side light, such as an ordinary studio, and with the apparatus properly adapted for this purpose. For full details see *Quarter Century in Photography.*

Portable Tent. (See *Tent.*)

Position. The placing of the model in the manner best calculated to attain the end in view by the artist. Such positions as are most natural and easy, and which exhibit the peculiar habits of the individual, are preferable. Many have endeavored to systematize the true principles of position; but as a general thing, rules are out of the question. Tasteful effect is one of the most indispensable additions to an agreeable portrait, and nothing should be neglected in order to obtain it. The artist must thoroughly study the effects of the particular light with which he has to work; the effect of reflectors and screens, the conformation of his model, the nature of his habits, and the peculiar outline of his features, selecting the best aspect of the face, and determining the best distance from the camera at which he should be placed, so as to avoid distortion or enlargement of parts.

Positive. A term used in contradistinction to "negative," and referring to all photographic pictures obtained in the natural state of light and shade. Positives are of two kinds: *direct*, or such as are produced directly in the camera, either on glass, paper, or other substance, coated with collodion, albumen, or similar substances; and such as are produced upon paper, wood, or other substance by superposition of the negative. Positives are also *transparent* or *opaque*. Transparent positives are such as are viewed by transmitted light. *Direct* positives are produced upon iodide of silver, while those of *superposition* are usually made upon the chloride; but they can be made upon a chloriodide by the development process. (See *Printing by Development*. See also *Ambrotype; Collodion Positives; Positive Process; Positive Proof; Printing*, etc.)

Positive Collodion. There is a very slight difference between positive and negative collodion; the former should be slightly thinner than the latter, and of a nature to give a pale blue and transparent film instead of the rich creamy film necessary for the negative. It is also necessary to the best results that all the chemicals used in its manufacture should be perfectly pure. The best proportions of alcohol and ether are as 3 to 5; while for negative collodion, equal parts are best. See *Ambrotype; Collodion Positive Process*, etc.)

Positive Collodion Transfers. (See *Transfers; Transferring*, etc.)

Positive Impressions. (See *Positive Proofs*.)

Positive Paper. The paper upon which positive proofs are printed. Paper prepared with the positive solutions for printing purposes. Paper is now manufactured expressly for this purpose; still, much of it is of inferior quality and every sample should be well examined for metallic spots and other imperfections as described in the article on *Permanence*. (For the methods of preparing paper for positive process, see *Printing*.)

Positive Paper, Instantaneous. (See *Instantaneous Positive Paper*.)

Positive Process. (See *Ambrotype; Collodion Positive Process; Printing*, etc.)

Positive Processes. All processes by which a positive, as distinguished from a negative, image is obtained are included under this heading. Albumen paper printing, platinotype, collodio- and gelatino-chloride, bromide, iron, and carbon processes are all positive printing processes.

Positive Proofs. The impressions made upon positive paper in contact with the negative, and finished in the toning and fixing bath. The completed papyrograph, or photographic picture on paper. (See *Printing*.)

Positive Solutions. The solutions used in the preparation of positive paper and printing processes. They consist of the *salting* solution; the *ammonio-nitrate of silver* solution; toning-bath and fixing-bath; *albumen* solution, and solution of *gelatine* or analogous substance. (See *Printing*.)

Positive Toning. (See *Toning*.)

Positives, Alteration of. (See *Fading*.)

Positives, Backing of. (See *Backing Positives*.)

Positives on Glass. Showing as such by transmitted light; also called diapositives or transparencies. Lantern slides are glass positives.

Potash (Potassa). Pure anhydrous potassa is a white solid substance, highly caustic and corrosive, fusible, and possessing a powerful affinity for water, intense heat being evolved during its combination with that fluid. The hydrate of potassa is the *potassa fusa* of the shops. Potash exhibits alkaline and basic properties in the most marked degree, turning vegetable yellows *brown*, and blues *green*, and forming salts with the acids. Pure potash may be made by separating the carbonic acid from the carbonate of potash of commerce, by means

of caustic lime. Solution of potash absorbs carbonic acid quickly from the air, and should therefore be kept in ground-stoppered bottles. The stoppers must be wiped occasionally in order to prevent them from becoming immovably fixed by the solvent action upon the silica of the glass.

Potassium. The metallic base of potash. To prepare, take perfectly dry carbonate of potash, 2 parts; powdered charcoal, 1 part; mix, place them in a gun-barrel or iron bottle, furnished with a short iron tube, and connected with a copper receiver containing a little naphtha and surrounded with ice, and distil by a strong heat. Potassium is solid at ordinary temperatures, but softens at 70° and fuses at 150°. It sublimes at a low, red heat; color and lustre resemble mercury. Sp. gr. 0.865. Its most remarkable property is its affinity for oxygen gas, which is so great that it takes it from most substances containing it, and it can only be preserved in naphtha or other fluid hydrocarbons. It is decomposed with the evolution of light and heat by contact with water, and a solution of pure potassa results. It unites with oxygen, forming oxides, one of which is potassa and the other a *peroxide*. Potassium is used for platinum paper and in the platinum toning-bath.

Pouncey's Carbon Process. (See *Carbon Process.*)

Powder Process. (See *Dusting-on Process.*)

Powder Enlarging Process. A valuable process for enlarging by transfer upon paper is thus described in the *News Year-book:*

Make an enlarged transparency, and varnish it; work up as much as necessary with lead-pencil. Now take clean glass plate of the same size. Rub well with French chalk, slightly dust. Coat with plain collodion (iodized collodion will do if plain collodion is not ready to hand). When dry, coat with one of the sensitive mixtures for powder process given above. Dry perfectly over gas stove or spirit lamp in dark-room. While still warm, print under the transparency, about three to ten minutes, according to light. The image will be faintly visible. Dust on, with large camel's-hair brush, finely-powdered ivory-black with a little Indian-red or any other color according to taste. When fully developed, cover with collodion, and place in dish with slightly acid water. When all the yellow is washed away let the plate dry. To transfer, take a piece of autotype double transfer paper, soak in warm water till slimy. Wet the plate, and apply paper; squeegee and let dry. If all has gone well, it should leave the glass readily. These prints are of course permanent.

Powell Print. The cyanotype, or blue print, because of the ease of its production, has long been a favorite with many amateur photographers; but its objectionable color, and the lack of purity in the whites of blue prints have caused many efforts to be made to secure a method by which the tone could be changed. Some years ago Mr. Samuel Powell perfected a process by which this desirable end may be attained. This process is as follows: He passes any good hard-sized paper suitable for the cyanotype picture through a bath of dilute gelatine, which he prepares as follows: Two and a quarter grains of gelatine to each ounce of water; after passing the paper through the gelatine bath it is hung up to drain and dry, using all precautions to avoid unevenness of coat, streaks, and marks; when quite dry the sized paper should be, in the dark, evenly coated with a solution composed, say, of seventy grains of ammonio-citrate of iron, with sixty grains of ferridcyanide of potash in two ounces of water, which should be prepared and kept in the dark. This is then the prepared paper, which, when duly exposed under a negative to light, may produce the variety of image desired. When printed it is washed in two or three changes of clear water, and we have the developed print no longer sensitive to light. This print needs now only to be blotted off from superfluous water, when it is ready for immersion in the discharging bath. The discharging bath may be composed of a variety of agents, such as—

(*a*) The carbonate, bicarbonate, sesquicarbonate of soda.

(*b*) The soluble alkaline silicate of potash and soda.

(*c*) Biborate of soda, known as borax.

Any of the above reagents dissolved in the proportion of ten grains to the ounce of water will discharge the color of the "blue print," still leaving the salt of iron in the form of a nearly invisible and perfect image on the paper.

He preferred to combine the discharging bath of ten grains of efflorescent sesquicarbonate of soda with each ounce of water. In this bath immerse the "blue print" till the color is discharged and the paper loses

nearly all trace of the picture, except a rusty color, more or less distinctly marked with the image in the strong shadows. When the blue color has vanished in the discharging bath the paper is washed in two or three changes of clear water, and then blotted off to remove any remaining traces of soda salts, which, if left in the print, would modify final color. The print is now ready for the toning-bath, for which we may employ gallic, tannic, or pyrogallic acid, or any other suitable compounds of tannin or such other agents as are known and employed to produce color reactions with salts of iron. Mr. Powell prepared his coloring-bath of four grains of gallic acid to the ounce of water, in which immerse the print, and then watch carefully for the development of the desired color, which, when it appears, is the signal to remove the print from the bath, and to pass it once rapidly through clean water, so as to wash it fairly, then immediately blot off all superfluous water, and dry it in full daylight, and preferably in the sun, which strengthens and increases its brilliancy.

Praxinoscope. An apparatus invented by Muybridge, by means of which a series of photographs (single exposures of a person or an animal in motion) may be conjoined into real motion-pictures. They are, by means of electric or lime-light, projected upon a white screen, so as to be seen by a large audience simultaneously.

Precipitate. A substance, which, having been dissolved, is again separated from its solvent and thrown to the bottom of the vessel, by pouring another liquid upon it.

Precipitation. The separation of a body from a liquid by the addition of a third body which has a greater affinity for one of these bodies than that which first combined with it.

Preliminary Bath. A bath into which plates are placed before development or other bath treatment, and which serves to accelerate the subsequent process. It is applied, for instance, in cases of very short exposures, (snap-shots, flash exposures) to be developed with oxalate of iron. In this case it consists of very diluted hypo solution. It is also used, when dry plates are to be rendered color-sensitive by erythrosin, in which case the preliminary bath consists of diluted ammonia, which increases the general sensitiveness and causes equal distribution of the erythrosin through the plate in the subsequent color-bath.

Prepared Plate Box. A box in which to preserve prepared glass plates. It consists of tin with grooves of gutta-percha or vulcanite, each groove calculated to hold two plates placed back to back. The box is perfectly light-tight, and has a very simple and effective fastening preventing any accidental opening. The box is made to suit the size of plate employed.

Preservative. A hygroscopic substance, with which a sensitive collodion film, from which most of the silver solution has been removed, is coated, to preserve its sensitiveness for a time.

Preservative Agents. Substances employed for the preservation of dry sensitive plates during the interval between their preparation and development. Many substances are now used, consisting of albumen, sugar, honey, oxymel, resin, gelatine, gum-arabic, tannin, malt, metagelatine and glucose.

Preservative Processes. Dry processes with preservative agents. (See *Oxymel Process; Metagelatine Process; Malt Process; Collodion-Albumen Process*, etc.)

Preservative Solutions. Solutions of the preservative agents.

Preserved Plates. Glass plates coated with collodion, sensitized, and covered with a preservative solution. (See *Dry Process.*) Plates prepared by any of the dry processes with keeping qualities.

Preserver. A metallic rim or border by which to inclose more securely the daguerreau picture and its glass covering.

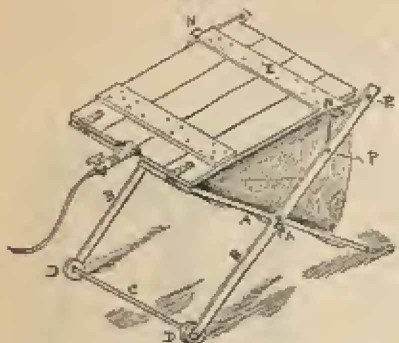
Pressing Photographs. After mounting photographs they are greatly improved by pressing. For this purpose the ordinary copper-plate press is used. The print is placed, face upward, upon the bed of the press, a piece of thin white paper laid upon it, and then a polished steel plate; it is then passed under the roller, coming out at the other side with a fine hard glossy surface.

Pressure-Board. An application on which the positive proof is printed. It consists of two boards hinged together and having a button attached to the back one of the pieces and movable upon the other. Upon the face are placed two or more springs to hold the negative and paper in their places during exposition. The progress of the printing is examined by turning the button and letting one-half the board drop away from the paper.

2. *Pressure-Board.* A well-known device for use with the magic-lantern. The India-rubber

bags filled with oxygen and hydrogen are placed between the hinged boards, as shown, upon which weights are placed for driving the gases from the bags. The figure shows

FIG. 163.



the rubber tubing leading from the bag toward the lantern. A third board is sometimes hinged to give place for another bag, thus making the same weights answer for both gases.

Pressure-Frame. An apparatus in which the positive proof is printed. (See *Printing-Frame.*)

Pretsch Photo-Tint Block Process. 1. Dissolve 1 ounce of Coignet's gold-label gelatine in 6 ounces of distilled water, and to 1 ounce of this solution add 30 grains of nitrate of silver, previously dissolved in ¼ ounce of distilled water; to the other 5 ounces of glue solution add 2 ounces of a saturated solution of bichromate of potash, and, while warm, add to it the nitrate of silver, and mix well; then stir in 100 grains of crystallized chloride of calcium, and add 150 grains of glycerine.

2. Level a glass plate, and pour over it as much of the above solution as will, when quite dry, form a film about the thickness of thin writing-paper.

3. Now expose the plate to the sunlight under a negative for about three hours, or until all the details of the picture appear when viewed by transmitted light.

4. Then wash it under water until those parts of the picture which are the least acted on by light become granulated, which is caused by a peculiar contraction of the film-the superfluous moisture must then be re; moved by blotting-paper.

5. A mould in gutta-percha or sulphur, taken from the film, and a reproduction of this mould, made by electrotyping or stereotyping, is the typographic block required.

Pritchard's Paper Process. By means of a glass rod, apply to a sheet of photographic paper a solution of

Iodide of Potassium	6 grains.
Distilled Water	1 ounce.

Pin up to dry and sensitize (also by iodide) with a solution of

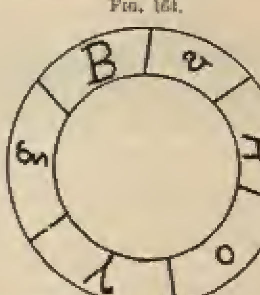
Nitrate of Silver	30 grains.
Water	1 ounce.
Glacial Acetic Acid	2 drops.
Iodide of Silver	½ grain.

Let the solution remain on the paper one minute, and then float it, sensitized surface downward, on distilled water, moving the vessel so that the water shall, for about half a minute, pass evenly and freely over the surface of the paper. Pin up; when dry, your paper is ready for exposure. Expose for seven, eight, or ten minutes according to the light. Develop with a saturated solution of gallic acid, with 2 drops to the drachm of acetic acid, and 1 drop of the 30-grain bath, and wash. Or, wax thoroughly and evenly a piece of paper, and by means of a sheet of blotting-paper and a hot iron, remove all superfluous wax from the surface. Apply, with a glass rod, the following mixture:

Iodide of Potassium	8 grains
Distilled Water	3 drachms.
White of 1 Egg.	

Froth thoroughly and allow to subside. Dry, sensitize, and wash as before.

FIG. 164.



Primary Colors. There are three primary colors, red, yellow and blue. In Fig. 164

the letters R Y and B represent these, and the smaller letters o g v, represent the compound colors. These facts are useful when selecting glass for a drying-room.

Primuline Process (Diazotype). A process of making positive colored prints on silk, paper, etc., from a positive. It is founded on the property of primuline (golden colored amorphous powder), of becoming nitrated by nitrous acid and transformed into a light-sensitive derivative. The resulting combination is diazo-primuline, producing naphthol-red when developed with β-naphthol, yellow with phenol, orange with resorcin, etc. After development the process is finished by washing in water.

Principal Focus. The precise point at which every portion of the photographic image assumes a clear, well-defined appearance. In taking a picture this point should always be sought and produced. (See *Focussing.*)

Print. A positive proof from a negative on light-sensitive paper. Such are usually made by exposing the paper under a negative, in a printing-frame, to the light, after which they are toned, fixed, and washed.

Print-Cutter. (Bergner's.) A useful machine for precise trimming of photographic

FIG. 165.

prints. The prints are placed upon the table, A B, and passed under the top, C, through a slit over the die or punch, D. The handle, E, is then brought down and the punch, D, is made to rise, thus cutting the prints from the sheet.

2. *Print-Cutter.* (Burgess & Lenzi's.) The print is placed upon a revolving table with a metal form. These are kept in place by the clamp moved by the foot, as seen in Fig. 166; while the circular table revolves under the knife by means of the hands of the operator the print is trimmed.

FIG. 166.

Printing. The art of producing positive photographs on paper or other substances by means of the negative and the positive solutions. (See *Photographic Printing.*) Besides the various processes already given in this work (for which see INDEX at the end of the volume, and also *Albumen Printing Process; Carbon Process; Photo-Xylography; Printing by Development*, etc.), there are here given several of the best of the most recent processes with the salts of silver:

1. *Printing on Albumen Paper.* Albuminate of silver yields an image with well-marked contrasts—rather hard, even; the chloride, on the contrary, a picture which may be pronounced as too uniform, or flat. Therefore, by varying the proportions of these two elements, by employing simply albumen more or less salted, or a paper more or less porous, the operator can obtain at will any effect he may desire. But this will not be sufficient; the positive proof must also possess another quality—it must be in good condition for toning. Now every photographer has remarked, 1, that a proof that always remains red or brown, and becomes of

a red metallic color, never tones well; 2, a proof tones well when, on removal from the pressure-frame, the shadows are of a green bronze metallic color; the toning being much more rapid and beautiful as the metallization is more advanced and greener in hue.

This is but a consequence of a fact which I shall now explain, *i. e.*, the toning consists of a precipitation of gold from the bath by the metallic silver which forms the image, a precipitation similar to that which takes place in the same bath when the image, instead of being formed of molecules of silver, is formed of molecules of copper or of zinc; only the silver, which belongs to the same sensitive group as the gold, can only precipitate the latter metal slowly and with difficulty. This established, we may easily comprehend that the more molecules of metallic silver there are upon a given point of the positive, the more prompt and abundant the toning will be. To obtain a good toning consists, therefore, of accumulating as much metallic silver as possible in the reductions which form the image. And this is the part the nitrate of silver plays. A sheet of paper imbued with nitrate of silver only will give an image; but it requires two whole days' exposure in the sun; while in the presence of chloride and albuminate of silver, the reduction of the nitrate of silver proceeds more rapidly. The proportions of nitrate must not, however, be unreasonably increased in the positive baths. Too large a quantity of this salt remaining on the proof either maintains the paper in a constant state of moisture, the image being of a uniform blue or gray tone, or in the crystallizing it will break up the surface and produce a multitude of holes, and destroy the negative also. If the quantity of nitrate cannot be conveniently reduced below 20 per cent., it ought not to exceed 40 per cent. A proof when taken from the pressure-frame is formed of three superimposed images, the first furnished by the albuminate, the second by the chloride, and the third by the nitrate of silver.

The albuminate and the chloride, in well-chosen proportions, give the true relations of light and shade. The nitrate of silver, in reducing itself with facility by the presence of the chloride and albuminate, accumulates metallic silver in every part where reduction takes place, and thus powerfully contributes to apply the element necessary to toning.—*L'Abbé Pujo.*

First Process. For albumenizing, the best paper should be selected, and the right side marked with a pencil at one corner. The albumen should be from fresh eggs, carefully separated from the yelk and germ. The proportions as follows:

Albumen	15 ounces.
Water	5 "
Chloride of Ammonium	300 grains.

Dissolve the chloride in the water first, and then add the albumen, and beat up with a bunch of quills for fifteen or twenty minutes. This solution should be allowed to stand three or four days, and the upper portion poured off for use in the following manner: pour the solution into a flat dish to the depth of half an inch, and draw off the scum with a slip of paper. Now lay the smooth side of the paper down on the solution, carefully avoiding air-bubbles, and allow it to remain for one minute; lift it by the corners, and dry at a moderate distance from the fire; or, if a large quantity is to be made, hang up in a warm room. To sensitize, make a solution of

Nitrate of Silver	80 grains.
Distilled Water	1 ounce.
Acetic Acid, 5 drops to 10 ounces of solution.	

Filter. Float the paper on this solution for five minutes and hang up to dry as before. Upon removal from the pressure-frame, the print should be placed in a dish of water, and thoroughly washed, to remove the free nitrate of silver. This water should be changed several times, and to the last a tablespoonful of common salt should be added, to convert any remaining nitrate of silver into chloride. The prints are now ready for immersion in the *toning-bath*, made of

Water	½ pint.
Chloride of Gold	1 grain.
Carbonate of Soda	5 grains.

The prints are to be immersed in this solution, and kept constantly moving about to avoid air-bubbles and stains. When sufficiently toned, which will be generally in three or four minutes, a little practice and judgment being necessary to determine the right point of color, they are to be removed and well washed. Then place them in the *fixing-bath*, composed of

Hyposulphite of Soda	6 ounces.
Water	1 pint.

The fixation will probably be complete in from five to ten minutes, to insure which the print should be kept moving constantly. It should then be held up to the light and examined; if there be no measly spots, and the print is evenly transparent, the operation is perfect. The fixing solution should not be used for more than two or three batches of prints. The proofs must now be well washed, either placed in a dish under a tap, or in running water; they can be left to soak ten or twelve hours; then hang up to dry. It is well to observe the following precautions: 1st. The nitrate bath should never be allowed to fall below 60 grains to the ounce. 2d. The prints should not be immersed in the toning-bath too many at a time. 3d. The sensitizing, printing, toning, and fixing should be performed on the same day. One grain of chloride of gold will tone about four pictures in seven or nine minutes.

The manipulating details in the various albumen processes differ so little that it is not necessary to repeat them in every case. Therefore only the formulæ are given below, thus allowing the operator to use his own judgment in modifying the practice given for the first process.

Second Process:

Albumen	1 ounce.
Water	1 "
Chloride of Ammonium	8 grains.

Whip into a froth; let subside for two or three hours, filter through fine linen; then float the paper, and dry. Sensitize with—

Nitrate of Silver	70 grains.
Water	1 ounce.

Tone in

Chloride of Gold	5 grains.
Water	1 ounce.

Fix in

Hyposulphite of Soda	4 ounces.
Water	10 "

The fixing-bath should not be used over one day old.

Third Process:

White of Eggs	8 ounces.
Water	8 "
Chloride of Ammonium	30 grains.

Treat as before directed. Sensitize with

Nitrate of Silver	60 grains.
Water	1 ounce.

Tone and fix as for No. 1 or No. 2.

Fourth Process:

White of Eggs	5 ounces.
Water	5 "
Chloride of Sodium	60 grains.

Sensitize with

Nitrate of Silver	40 grains.
Water	1 ounce.
Nitric Acid	1 drop.

Tone in any of the alkaline baths given in article on *Toning-Bath*, as above, or as given in other parts of this work. Fix as above. (See INDEX for other processes.)

II. *Printing on Plain Paper.* The formulæ for printing upon plain paper are more numerous even than those for albumen. The manipulations for these formulæ vary but little; in the first process, therefore, details are given in full; in those which follow, the formulæ only, unless some marked modification is indicated. In the choice of paper for *plain proofs*, its purity and freedom from all metallic, grease, or other spots is even more essential than for albumen prints.

First Process. The first preparation is the *salting*. For this purpose take of water, say, 20 ounces; common table salt, 30 grains; dissolve the latter and filter. Put this into a flat dish from two to four inches each way larger than the sheets of paper to be salted. Place your paper upon a clean board, smoothest side upward, and turn two of the corners over sufficiently to give you a good hold with the thumbs and forefingers; the corners thus turned up point out the side upon which to apply the sensitizing solution, and also serve to prevent stains from the fingers, or the pins by which the sheet is hung up—that is, if you are sufficiently careful to keep these corners dry while salting, which you should be. Take the paper by these corners between the thumbs and forefingers so that the surface lying uppermost shall be toward you; bend the sheet slightly between the corners, and *push* it under the solution slowly and carefully, so that every part of the sheet may gradually and evenly imbibe the liquid; do not be in too much of a hurry, or you may not only have your sheet unevenly salted, but you may scrape it upon the bottom of the dish, which would be apt to cause stains during some part of the after-process. Having drawn the sheet out at the opposite end of the dish, this one immersion, if properly done, will be quite sufficient;

but if any dry spots are left in the sheet it must be passed through again, and then hang it up to dry in a room free from dust and the fumes from chemicals. Sensitize with the ammonio-nitrate of silver, made as follows:

Nitrate of Silver	1 ounce.
Water	20 ounces.

After solution, pour five ounces into your measure and add *aqua ammoniæ fortis* drop by drop, stirring continually with a glass rod, to the fifteen ounces until precipitate formed by the first additions is nearly all re-dissolved, and the liquid has but a slight tinge; then pour back the five ounces, and filter. This solution may be put into a flat dish, and the paper floated upon it for three or four minutes according to the hardness of the sizing of the paper, and hung up to dry, or it may be spread on with a brush. This latter plan is the best, and may be performed in the following manner: Provide yourself with a board slightly curved on the upper side, about one-fourth of an inch smaller than the paper to be used, having the four corners bevelled off. Place as many sheets as desirable upon this board, and pin the corners to the bevelled corners of the board, the pins horizontal to and below the surface of the board, so that they will not interfere with the brush. The brush may be made in two ways: Take a strip of glass one inch wide and six inches long, and around one end wrap a strip of cotton batting about two inches wide, and tie it down at the inner edge; or take a piece of wood 2 or 3 inches long and 2 inches wide, rounded upon one edge and bevelling off toward the other, and cover it with three or four thicknesses of cotton flannel, sewing them tight along the upper or narrow edge. With either of these ready, pour upon the centre of the sheet sufficient of the ammonio-nitrate solution to cover the sheet when well spread, say about a tablespoonful if it be a full-sized sheet; then spread it, first with a circular motion fully up to the edges, and afterward go over it lengthwise and crosswise until the paper has completely absorbed the liquid and will not drip when hung up. Take the sheet off by the turned corners and hang up to dry. When dry, place the paper in a dark box for use. Expose under the negative in the sun, or to diffused light. We prefer the latter as giving more strength and better gradations of light and shade, until slightly over-printed, and a coppery hue is obtained. Tone and fix in a bath made by either of the following formulæ:

1. Hypo Soda	8 ounces.
Water	½ gallon.
Chloride of Gold	45 grains.
Salt	240 "
Acetate of Lead	200 "

Dissolve the gold in 1 ounce of the water, and the hypo in the rest, and after perfect solution pour the gold into the hypo; then add the gold and acetate and shake until all is dissolved. Immerse the prints in this bath, keeping them moving constantly until they assume a purple tinge, and the shadows are clear and the high lights clear and brilliant; then place them in a trough of running water for from twelve to sixteen hours; hang up and dry.

Second Process. Salting solution:

Water	1 pint.
Chloride of Ammonium . . .	1 drachm.

Sensitizing solution:

Water	1 ounce.
Nitrate of Silver	60 grains.
Aqua Ammoniæ	q. s.

Toning-bath:

Hypo Soda	1 ounce.
Saturated Solution of Iodide of Silver in Hypo	2 grains.
Chloride of Silver	15 "
Water	6 ounces.

Fixing solution:

Hypo Soda	1 ounce.
Water	8 ounces.

A solution of chloride of gold, 1 grain to the ounce, may be added to the toning-bath if black tones are required. Fine sepia and brown tints are given without it.

Third Process. Salting solution:

Water (warm)	1 ounce.
Gelatine	1 grain.
Salt	2 grains.

Dissolve the gelatine, then add the salt. The sensitizing solution the same as for the first process. The toning bath as follows:

Hypo Soda	8	ounces.
Chloride of Gold	45	grains.
Chloride of Silver	½	ounce.
Chloride of Lead	1	ounce.

Fourth Process. Salting solution:

Chloride of Ammonium	1¼ grains.
Chloride of Sodium	1⅓ "
Water	1 ounce.

Sensitizing solution:

Nitrate of Silver	60 grains.
Water	1 ounce.
Aqua Ammoniæ	q. s.

Toning-bath:

Chloride of Gold	1 grain.
Carbonate of Soda	⅓ "
Water	1 ounce.

Fixing solution:

Hypo Soda	1 ounce.
Water	1 pint.

The print must be toned first, and then placed in the fixing-bath from five to ten minutes, according to the strength of the print and the color desired. (See INDEX; *Printing Glass Positives; Printing by Development*, etc.)

Collodio-Chloride Prints. When collodion "Aristo" papers are used, the best results may be obtained by the use of the toning-baths advised by the manufacturers of the paper in question. For those who prefer to tone and fix their prints separately any of the following baths will be found reliable:

Water	18 ounces.
Acetate of Soda	75 grains.
Borax	75 "

Add neutral gold enough to tone.

or:

Water	48 ounces.
Tungstate of Soda	150 grains.

Add neutral gold enough to tone.

These baths should be made up a day before they are to be used, and should always be alkaline. For fixing collodion prints the fixing-bath should be quite weak, 3 ounces of hyposulphite of soda to 64 ounces of water (or 1 in 20) will be found to be sufficient. Fixing should continue fifteen or twenty minutes.

Gelatino-Chloride Prints. In the manipulation of gelatino-chloride paper, as with commercial collodion papers, it is advisable to follow the formulæ given by the various manufacturers. It should not be forgotten that gelatine papers require to be preserved from moisture before and during printing, and that they should always be treated with cold solutions, and an alum bath or "hardening" mixture is often necessary to keep the film firm during the manipulations. Welford recommends the following bath for toning gelatine papers:

Gold Chloride	4 grains.
Bicarbonate of Soda	1½ drachms.
Water	6 ounces.

For *firing gelatino-chloride prints separately*, use:

Hot Water	1 gallon.
Borax	½ ounce.
Hyposulphite of Soda	8 ounces.
Powdered Alum	3 "

This bath must be used cold, and made not less than two days before used, that it may be clear. It keeps, and should be prepared in quantities. Do not use a plain fixing-bath, as it will soften the film.

For blue-black tones on gelatino-chloride papers Liesegang advises

Water	25 ounces.
Sulphocyanide of Ammonium	1 ounce.
Phosphate of Soda	1 "

A few hours before toning add to 10 ounces of this solution a solution of 5 grains of chloride of gold in 1 ounce of water. After this bath has been used add some more of the gold solution; it can then be used again.

A uranium and gold toning bath, which requires separate fixing and is applicable to collodio-chloride and gelatino-chloride paper, is given as follows:

Chloride of Gold	4 grains.
Nitrate of Uranium	4 "
Chloride of Sodium	60 "
Acetate of Sodium	60 "
Distilled Water	16 ounces.

Dissolve the uranium and gold in a little of the water, and neutralize with chalk.

Lithium Toning-Bath for Gelatino-Chloride Prints. The subjoined bath is said to give delicate half-tones and rich shadows when used with gelatino-chloride printing paper:

Carbonate of Lithium	1 drachm.
Water	8 ounces.
Chloride of Gold	2 grains.

The free silver must be eliminated from the prints by washing before toning, and the toning-bath used as soon after preparation as possible.

Platinum Toning for Solio Paper. First tone very slightly indeed to a light-brown in the following (the prints having been previously washed as usual):

Potassium Chloro-platinite	. .	5 grains.
Sodium Chloride	. . . .	40 "
Citric Acid	. . . . .	40 "
Water	. . . . . .	20 ounces.

and immediately transfer direct to the combined toning and fixing bath following:

Stock Solution No. 1.

Hypo	. . . . . .	6 ounces.
Potash-Alum	. . . . . .	$1\frac{1}{2}$ "
Sodium Sulphate (Glauber's Salt)		4 "
Water—make up to	. . .	60 "

First dissolve the hypo and alum in the water, then add the sodium sulphate.

Stock Solution No. 2.

Gold Chloride	. . . . . .	15 grains.
Acetate of Lead (Sugar of Lead)	.	50 "
Water	. . . .	$7\frac{1}{2}$ "

To form a combined bath, take of

Stock Solution No. 1	. . .	8 ounces.
Stock Solution No. 2	. . .	1 ounce.

Combined Toning and Fixing Baths are recommended both for collodio-chloride and gelatino-chloride papers; the two here given are very popular:

(1) A. Water	. . . . .	24 ounces.
Hyposulphite of Soda	.	6 "
Sulpho-cyanide of Ammonium	. . . . .	1 ounce.
Acetate of Soda	. .	1 "
Saturated Solution of Alum		2 ounces.

B. Dissolve 30 grains of nitrate of silver in $\frac{1}{2}$ ounce of water.

Add 30 grains of common salt, and stir well till a white precipitate is formed.

Pour B into A, and leave it for a day. Then filter, and add the following solution:

C. Water	. . . .	6 ounces.
Chloride of Gold	. . .	15 grains.
Chloride of Ammonium	. .	30 "

The bath will keep for any length of time. It can be used over and over till the light half-tones of the print become of a greenish hue, which is an indication that the fixing agent is exhausted, when it must be replaced by a fresh bath.

(2) 1. Hyposulphite of Sodium	.	20 ounces.
Alum-Potash	. . .	5 "
Potassium Sulphate	. .	2 "
Sodium Sulphate (Glauber's Salt)	. . . . . .	10 "
Water	. . . . . .	160 "

First dissolve the hyposulphite of soda and alum in the water, then add the potassium sulphate and sodium sulphate. *Allow to stand for two or three hours before using.*

2. Chloride of Gold	. . .	15 grains.
Acetate of Lead (Sugar of Lead)	. . . . .	64 "
Water	. . . . . .	8 ounces.

For use: Take of No. 1 eight ounces and of No. 2 one ounce. The No. 2 solution should be well shaken before being added to No. 1. Prints should be immersed in this bath without previous washing.

Gelatino-Chloride Prints by Development. Liesegang recommends to make a weak print and then to plunge it, without previous washing, in

Gallic Acid	. . . . .	5 grammes.
Acetate of Soda	. . . . .	5 "
Tannic Acid	. . . . .	3 "
Water	. . . . . .	350 c.c.

It will develop entirely of a warm black. In a solution of hyposulphite of soda it will turn green, whilst in a mixed toning-bath it will acquire a warm tone. This bath may be used several times if care be taken to separate the precipitated silver by filtering.

Printing by Development. This process differs from the method already described in being produced upon iodide and chloride of silver, in a manner which renders developing necessary, as the impressed image is at first latent; it may also be executed either by the camera or under a negative, rendering it peculiarly adapted to the enlarging cameras. There are several methods of printing by development.

I. Immerse the paper in a solution of common salt, 160 grains; hydrochloric acid, 10 drops; water, 20 ounces. Let it soak some hours. Excite by floating it upon a solution of nitrate of silver, 50 grains; citric acid, 1 grain; water, 1 ounce, for three minutes; then hang up to dry by *two* corners, and put a slip of blotting-paper along the bottom. Let the paper become *surface* dry, and while it is still damp place it in contact with the negative as usual and expose to light until there is a faint image. Develop as follows: Turn up the edges of the print and make it into a tray, and lay it on a sheet of blotting-paper; then in a clean measure-glass put a sufficient quantity of the solution (say 1 ounce for a 10×8 print): pyrogallic acid, 2 grains; citric acid, 1 grain; water, 1 ounce. Take the measure-glass in the left hand and a glass triangle in the right, and pour the solution smartly down one side of the tray, and with the triangle spread the liquid cleverly all over the paper; this opera-

tion requires some practice, for if not performed neatly, the picture will be stained, just as a collodion negative would be. The picture develops very quickly, and must be closely watched. If all is right, the deep shadows come up first, and strengthen considerably before the half-tones and finer details of the high lights show themselves. As soon as it looks vigorous and powerful enough (recollect, the fixing does *not reduce the print at all*), take hold of the tray by two corners, and turn the developing solution into the waste-pan and wash the print well under the tap; then fix in hypo soda, 1 ounce; water, 1 pint, letting the proof remain twenty minutes or half an hour; afterward wash as usual. Caution: The paper must never be used without the acid in the salting solution; with other papers it may be omitted. Care must be taken not to get too much citric acid in the sensitizing solution, as it lowers the tone, and half-tones are not fully developed; the formula must be followed exactly.

II. This is a modification of No. I. Salt the paper in solution of 8 grains of salt to the ounce of water; sensitize by floating for four or five minutes on water, 1 ounce; nitrate of silver, 20 grains; citric acid, 2 or 3 grains. Print until the image is just visible, and develop in the same manner as I., with solution of gallic acid, 5 grains; water, 1 ounce. Of course, all the solutions must be filtered before use. Fix, wash, and dry as before directed.

III. Float or brush the paper with a solution of bromide of potassium, 4 grains; iodide of potassium, 1 grain; gallic acid, ¼ grain; water, 1 ounce. Dry in the dark. Sensitize with nitrate of silver, 20 grains; acetic acid No. 8, 1 drachm; water, 1 ounce. Expose from five to fifteen seconds according to the strength of the light; then a very faint image is perceptible with difficulty. Develop with a saturated solution of gallic acid in water by brushing with a pad of cotton, occasionally adding a drop or two of the aceto-nitrate of silver solution upon the wad until the image is fully brought out; fix in hypo 4 ounces to 1 pint of water; then wash thoroughly in running water, say five or six hours, and dry. Care must be taken not to let the slightest particle of light touch the paper during the manipulation, until it is finally fixed. The paper may be used well in the enlarging cameras. (See INDEX.)

Printing by Electric Light. (See *Electric Light.*)

Printing Glass Positives. (See *Chemitype; Printing Transparencies,* and INDEX.)

Printing Transparencies. Photographic positives on glass to be viewed by transparency may be printed by several methods:

I. Gum a slip of paper down each side of the face of the negative. Prepare the glass plate in the usual way with collodion, and, after removing it from the nitrate bath, allow it to drain with its lower edge upon a piece of blotting-paper for two or three minutes; then place the negative on it, face to face, securing them together by two or three patent clothes-clips, and hold them to a gas-light. The time of exposure will be from one to three minutes. The negative, of course, must be toward the light. Develop with

Pyrogallic Acid	3 grains.
Citric Acid	3 "
Water	3 ounces.

adding a few drops of the nitrate bath to the developing solution after it is poured off for the first time. Any degree of blackness can be obtained with this formula.

II. Coat and sensitize a glass plate with collodion, place it wet upon a blackened surface, and cover the collodion surface with a prepared film of gutta-percha, or transparent paper, taking care that no bubbles get between the two films; the negative is then placed upon the whole and exposed, and after the removal of the negative and the gutta-percha film the picture is developed with the ordinary iron developer. To obtain the gutta-percha film, a solution of the gum in benzole may be placed upon a clean glass plate, and when dry removed by immersion in water. Mastic varnish may be mixed with the gutta-percha in the proportion of ½ to ⅔. This addition renders the film firmer and less liable to curl up from the warmth of the hand, and also more transparent. The transparent gutta-percha film is liable to become spotted by being in contact with the silver solution, but the spots may be removed by washing with cyanide of potassium. When the film has been once used and is required again before it becomes dry, the nitrate solution will be found to have gathered concentrated drops, and if a print is taken without a previous washing in water, dark spots will mar the appearance of the impression; in

this case, it is requisite to be careful when laying the film upon the collodion surface to raise and depress it several times, so as to allow the concentrated drops on the film to become equally diffused with the solution on the collodion surface.

III. Prepare the plates after the method for the dry collodion albumen process; expose them, dry, under the negative in the ordinary pressure-frame, either to a strong gaslight, or in the open air for a few seconds; then develop with a solution of pyrogallic acid, 3 grains; citric acid, 1½ grains; water, 2 ounces. Having soaked the plate in water for one or two minutes, take two fluid-drachms of the solution and add 10 minims of a 20-grain solution of nitrate of silver; then pour the liquid repeatedly on and off from a measure. The image begins to appear in one minute, and is fully brought out in from five to eight minutes. Toward the end of the development the pyrogallic acid discolors and may be thrown away. If not fully brought out by the first application a second portion of the solution is to be used. The pictures are fixed with plain hyposulphite of soda solution, and afterward toned by any of the toning formulas.

IV. Transparencies may be printed in the camera. The camera may be the ordinary sliding camera with a portrait combination lens of 3 inches diameter. A stop of 1½ inches aperture can be used when necessary. This lens requires the focus to be taken on the extreme edges of the picture, to give the required sharpness all over. Place the camera at one end of a board four feet long, and the same width as the camera; and at the other end the screen carrying the squared lenses and the negative; this screen, or illuminating apparatus, consists of a wooden screen with two double-convex lenses inserted side by side, each lens being cut to a rectangular shape of the size of one of the pictures of the negative, the centre of each lens being placed exactly opposite the centre of each picture; the focal length of each lens is twelve inches. A ledge and spring keep the negative in its place, and a matt, which may be of any form, is used to limit and define the outline of the picture. A movable standard, carrying two argand gas-burners, capable of adjusting to any height and at varying distances apart, is furnished with a flexible tube, in order to convey a supply of gas to the burners. This description is for stereographic pictures; for single pictures a single lens and burner are used; with the gas lamp one foot behind the screen. Place the cap on the lens and see that both flames are well represented in focus; then make the picture of one of the flames overlap that of the other by regulating the distance between the burners, and you will find, on removing the cap, that both squares on the ground-glass are equally illuminated. Adjust the camera so that these two illuminated squares are exactly the size of the picture required, focussing as sharply as possible, and the apparatus will be in its proper position. Having proceeded thus far, it will be well to mark the position of the camera and screen on the board and to screw slips of wood thereon, so as to enable you at any future time to place the apparatus ready for work without having to go over the same ground again. Any collodion that will give intensity under ordinary circumstances will succeed; but if you wish for transparent shadows, develop with pyrogallic and acetic acids only. To print by daylight, place the screen close to a window having a north light. Dry plates for transparencies are supplied with formulæ. (See INDEX.)

Printing in Carbon. (See *Carbon Process*, and INDEX.)

Printing in Colors. M. Niépce de St. Victor gives the following directions for printing in certain colors:

Red color. Prepare the paper with a solution of nitrate of uranium, 24 grains to the ounce of water. Leave the paper from fifteen to twenty seconds in this solution, then dry it in the dark. Expose it in the pressure-frame from eight to ten minutes in sunshine. Wash it for some seconds in warm water (120° F.), and then immerse it in a solution of red prussiate of potash, 10 grains to the ounce. In a few minutes the print will acquire a beautiful blood-red color. Wash it in several changes of water, until the water remains perfectly colorless, and then dry it.

Green color. Take a red print obtained as above described, immerse it for a minute in a solution of nitrate of cobalt. Remove it without washing, and dry it before a fire; it will become green. Fix it by putting it for a few seconds into a solution of sulphate of iron, 20 grains to the ounce, and sulphuric acid 1 scruple to the ounce. Wash it once in water and dry it before a fire.

Violet color. Prepare the paper as in the red process. Expose it; wash it in warm water, and develop the image with a solution of chloride of gold, 2 grains to the ounce. When the print has acquired a fine violet color, wash it in several changes of water and dry it.

Blue color. Prepare the paper with red prussiate of potash, 100 grains to the ounce. Dry it in the dark. Remove the print from the pressure-frame when the shadows have acquired a light-blue tint. Immerse it for a few seconds in a cold, saturated solution of bichloride of mercury; wash it once in water, and then put it into a solution of oxalic acid, saturated when cold, and heated to about 100° F. Wash it three or four times, and dry. (See also *Chromo-Phototype.*)

Printing on Mica. Thin plates of mica (see *Mica*) have recently been introduced for printing with pigments (carbon process), covered with colored gelatine in the same way as pigment paper. These mica plates are sensitized by immersion in a solution of bichromate of potash, and printed like carbon tissue. In printing, the mica side, not the pigment side, should be turned to the negative, by which means a picture is produced without the necessity of transfer.

Printing on Textile Fabrics. To print on textile fabrics Messrs. Dreyfus & Worth, of Paris, have given the following method: The surface of the material is to be prepared successively with three baths, care being taken to sensitize only such portions as are to be exposed, and to dry the material after each bath. The *first* bath consists of a mixture of 3, 6, or 9 drachms of a saturated solution of chloride of sodium (according to the intensity desired) with 3½ ounces of distilled water. The *second* bath is a solution of 170, 310, or 465 grains of nitrate of silver in 3½ ounces of distilled water. The proportion of silver depends upon the whiteness of the ground; 10 per cent., for instance, for a light colored silk and 15 per cent. for a dark-colored. When the goods are dry, after the second bath, they are placed on a plate of glass, covered with the negative or drawing, then covered with another glass plate which is fastened on the other by means of screws, and finally exposed to the light, either direct or shaded according to the intensity desired to be obtained. The time required varies from five minutes to an hour. The *third* bath consists of 155, 310, or 465 grains of hyposulphite of soda dissolved in 3½ ounces of water, the strength as before being graduated by the shade or depth of impression. The last manipulation is a thorough washing in rain-water. If the color should be too dark, it may be reduced by a bath of potassium.

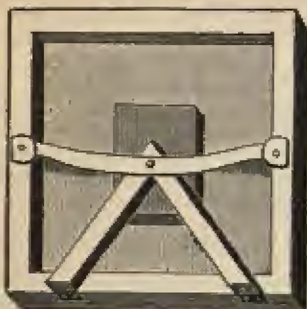
Printing with Nitro-Prussides. Very good prints may be made with the nitro-prussides by the following simple process: The paper is floated upon or washed with a solution of the nitro-prusside of sodium, dried, and exposed under a negative in the pressure-frame, until a faint indication of the image can be perceived; the paper is then removed and placed for a few moments in a bath of proto-sulphate of iron, of the strength of about 40 grains to 1 ounce of water. The picture is immediately developed, and is of a dark-blue color, the lights and parts of the paper not acted upon having a pink tint, which makes the picture seem rather weak and flat from want of contrast. All that remains to be done is to wash the print in clean water, which entirely removes the pink tint and leaves the picture thoroughly fixed; and as "Prussian blue" is a permanent pigment, the picture may be expected to stand the test of time. By adding various reagents to the water in which the print is washed, the color may be greatly varied or modified. Gelatine paper floated upon chloride of ammonium solution, 15 grains to 1 ounce of water, then on a solution of nitrate of silver, 40 grains to the ounce, allowed to dry, and finally on the solution of nitro-prusside of sodium, dried, and printed under a colored drawing, will form a beautiful *colored image*, like the *original*. This image is latent to reflected light, but perfectly visible by transmitted light; giving some hope as to the ultimate production of the natural colors by photography upon paper.

Printing-Frame. A wooden frame with a divided, hinged back, firmly held down against negative paper when loaded, by springs serving to bring negative and sensitive paper in close contact in order to obtain a sharp print.

Printing-Frame for Photography on Wood. Recommended by Charles Homan, who says: "I use a home-made printing-frame; I find it very handy for porcelain printing and many other things. I take an ordinary 8 by 10 frame and fasten a glass at the bottom. I fasten the glass in the print-

ing-frame with two little wedges of wood at the end of the glass. They hold it very firm, and are easily taken out when you wish to use the frame for other kinds of printing. On the top I fix a triangular-shaped piece of

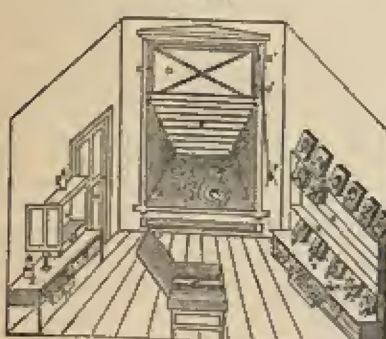
FIG. 167.



wood with hinges, making the point come at the middle of the frame, screwing a strip of brass across the point for a spring. I fasten the block underneath with wax, so it can be taken off. When you wish to print a block of wood, stick the negative on the plain glass with wax at the corners. For printing on wood, it is often necessary to use a reversed negative, which I get by first making a ferrotype, and whiten it with mercury; then make a negative from it.

Printing-Room. An apartment devoted to making positives from negatives exposed

FIG. 168.



to the light. It should be supplied with a printing-shelf, A. B is the sash of glass through which the light enters, kept in place by hooks at C. D is a window swinging back and forth by means of the hinges D′ D′, and fastened by the button E. F is the window-cord. G, the drawer in which the sensitized paper is kept ready for use. H is a drawer in which the prints are slipped through a slot at K. The slot should be covered from the light. L is the drawer in which a stock of paper is kept, and M a small drawer for other kinds of paper. P P are the negatives ready for printing, to be placed at P′ after using. The filling is done on a bench, T. U is a door leading to the silvering and toning rooms. V is the fuming-box. W, a box in which old hypo solutions are poured to save the waste; and X, a bench for general use.

Prism. The well-known three-sided glass body in which light-rays are refracted. For the production of reversed direct negatives used in the mechanical processes the prism is screwed to the objective in place of the front ring. It is made rectangular for this purpose; the plane of its hypothenuse is silvered. It is centred in its setting. Usually it is turnable, so that objective and prism may be turned around its axis and fastened in any position. Nicol's prism, designed by Nicol from calcium-spath, is so constructed that of the two rays into which a light-ray falling upon calcium-spath is split only one passes through it. This ray is polarized. Such a prism, consequently, is used for polarizing apparatus.

Prints. Photographic positive impressions upon paper, glass, or other substances.

Prismatic Analysis. The decomposition of light by the prism, by which the colorific rays are separated and made to assume each its distinct color and place in the prismatic spectrum. (See *Spectrum Analysis.*)

Prismatic Spectrum. The colored image produced by the decomposition of light by the prism. The original spectrum of seven bands of color was examined by Sir Isaac Newton, and that eminent philosopher found that a given degree of refrangibility indicated a given color, the color of a ray at once indicating its angle of refraction. This law, however, will not stand the test of examination. (See *Light.*)

Prism Stereoscope. An instrument for uniting binocular pictures to be seen in relief by means of a single prism, and to be viewed by one eye only.

Proof. In photography the picture, nega-

tive or positive, produced by any of the photographic processes.

Proto-Acetate of Iron. Dissolve freshly-precipitated protoxide or carbonate of iron in acetic acid; or add a solution of acetate of lime to another of proto-sulphate of iron and evaporate, out of contact with the air. Small, green, prismatic crystals are the result.

Proto-Chloride of Palladium. Proto-chloride of palladium is a brown crystalline mass, obtained by evaporating the nitro-muriatic solution to dryness. By heat it loses its water and turns black. Dr. Draper recommends the proto-chloride of palladium for intensifying negatives, and practical experience has proved that thin collodion positives can be intensified to dense printing negatives. The proto-chloride is sold in solution, and the best way to use it is to dilute it to the strength required, and keep it in a glass bath into which the *fixed* picture may be plunged and left until the full degree of intensity is obtained. This is limited, and no second application will increase it; on the contrary, it appears to diminish it; but very clear negatives are obtained in *black* by the one application. To succeed well the nitrate of silver bath must be acidified with *nitric* instead of acetic acid. One ounce of proto-chloride of palladium ought to make about 160 ounces of intensifier. It is also suggested as a toning agent in place of chloride of gold.

Proto-Chloride of Uranium. To prepare this salt, calcine nitrate of uranium in a small porcelain crucible furnished with a cover, at the melting-point of tin. In an hour the nitrate of uranium is decomposed into a reddish-yellow mass, which is to be finely pulverized and intimately mixed with double its weight of wood charcoal in a state of impalpable powder. This is made into a paste with oil and formed into pellets, which are calcined again in a closed crucible. These pellets are placed in a tube of hard German glass and heated to a dull-red heat, and a stream of dried vapor is then passed through the tube. The manipulation is exactly the same as that for proto-chloride of iron. The chloride of uranium is found in the cold part of the tube in little masses of a very decided green color. This should be weighed, dissolved, and treated with caustic soda, or potash, as directed for proto-sulphate of uranium.

Proto-Iodide of Iron. A compound of iodine and iron formed by dissolving 2 ounces of iron filings and 6 ounces of iodine in $4\frac{1}{2}$ pints of water, boiling in a sand-bath until the liquid turns to a pale green. Filter, wash the residue with a little water and evaporate the mixed liquors in an iron vessel heated to 212° F., to dryness. The proto-iodide of iron is used in the *amphitype* process (which see).

Proto-Nitrate of Iron. This salt is prepared by adding to iron filings, in a flask or bottle, dilute nitric acid. By concentrating the solution by very gentle heat, the salt will crystallize in green crystals, which are insoluble in alcohol, and must be preserved free from contact with atmospheric air. It is used in photography. (See *Proto-Sulphate of Iron.*)

Proto-Nitrate of Mercury. It is prepared by digesting mercury in excess in nitric acid diluted with four times its weight of water until the acid is saturated; evaporate and crystallize, leaving a globule of mercury in the liquid. By re-solution in water acidulated with nitric acid and spontaneous evaporation the salt may be obtained perfectly pure. (For photographic application, see *Mercury.*)

Proto-Salts. When there are two oxides of the same base, both of which are salifiable, in naming the salts the term *proto-* is prefixed to the acid of the salt formed by the lowest oxide.

Proto-Sulphate of Iron. Prepared by adding to very clean iron filings diluted sulphuric acid, made by mixing 1 part acid with 6 of water. This salt crystallizes in the form of an oblique rhombic prism, of a pale bluish-green color. When exposed to the atmosphere the crystals lose their original color and assume a dirty-brown appearance, but they may be preserved perfectly pure for a long period if kept in well-stoppered bottles. This salt mixed with the proto-nitrate of iron may be used for changing the negative collodion proof to a positive. It should be used as follows:

Proto-Sulphate of Iron . . .	10 grains.
Distilled Water	1 ounce.
Nitric Acid	2 drops.

Pour this over the developed and fixed plate, being careful not to carry the re-development too far. A solution of this salt may be used for developing images formed upon

fluoride or nitrate of silver. A very weak solution answers for this purpose. We can also restore dark tones to the positive proofs with the same solution. A negative rendered too dark by gallic acid may be brightened by submitting it to a bath slightly concentrated with a solution of proto-sulphate after fixing with the hyposulphite of soda and washing it with water. For developing negatives, mix

Proto-Sulphate of Iron	15 grains.
Tartaric Acid	15 "
Nitric Acid	4 drops.
Water	1 ounce.

For positive proofs employ the solution of proto-sulphate of iron made to the sp. gr. 7° of Twaddle's hydrometer, and then brought up to 8° by nitric acid. This solution is applied in the same way as gallic or pyrogallic acid. In the choice of proto-sulphate of iron, secure regular crystals, of a *pale-green* or *emerald-green* color, as those of a *bluish-green* contain an excess of acid which renders them unfit for the purpose. By submitting the salt to a heat of 100° C. nearly all its water of crystallization is driven off, and it is reduced to a powder, easily soluble in water, having very little bulk. In this form it is more convenient to carry. (See *Developer* and *Re-developing*.)

Proto-Sulphate of Uranium. An old-time developing agent.

Protoxide of Iron. This salt contains 1 atom of oxide to 1 atom of the metal. It is readily precipitated from solutions of the proto-salts as a white hydrate by pure alkalies, and as a white carbonate by the alkaline carbonates; both of which turn first green and then red by exposure to the air. It forms proto-salts with acids.

Prussian Blue. When a ferric salt is added to potassium ferrocyanide a blue precipitate of *soluble Prussian blue* is produced; to this ferric chloride is added and the ordinary commercial insoluble Prussian blue is produced.

If blue print paper is immersed in potassium *ferrocyanide*, instead of potassium *ferricyanide*, a negative print is obtained instead of the usual blue positive.

Pseudoscope. An optical instrument, so named on account of giving false perceptions of all external objects. It causes whatever points of an object are nearest to seem farthest off, and those farthest off to be nearest, and other more complicated and perplexing illusions are produced. The illusion is most extraordinary, a concave surface, that of a bowl, appearing to be convex, and, *vice versa*, a convex surface, as that of a globe, concave. It is formed of two rectangular prisms, interposed between the eyes and the object, in such positions that the rays of light from any object in front being refracted at the first surfaces, then reflected internally at the backs of the prisms and again refracted at their second surfaces, will enter the eyes in reversed positions, and thus the relative positions of the rays will be inverted.

Psychrometer. An instrument for measuring the tension of the aqueous vapor in the atmosphere.

Pyramidal Composition. The engraving is from Burnet's famous *Essays on Art*, and represents a form of composition much used in

FIG. 169.

grouping. A composition is not only arranged into pyramidal form, but its component parts may be divided into smaller pyramids, thus showing that the principle is carried out by the inner as well as the outer lines.

Pyrocatechin. Catechol; oxyphenic acid. $C_6H_4(OH)_2$. Brown or colorless transparent bars, very soluble in water, alcohol, and ether; reacts slightly acid. Used in alkali development.

Pyrogallic Acid. This acid is obtained by heating gallic acid, or pulverized nutgalls, in a porcelain basin or cup, covered over with a glass bell. Crystals of pyrogallic acid sublime upon the walls of the bell. It is necessary to control the heat under 200° to prevent the decomposition of the acid. Pyrogallic acid is very soluble in cold water and in alcohol and ether; the solution decomposes and turns brown by ex-

posure to air. It gives an indigo-blue color with protosulphate of iron, which changes to dark green if any persulphate be present. Although termed an *acid*, this substance is strictly *neutral*; it does not redden litmus-paper and forms no salts. The addition of potash or soda decomposes pyrogallic acid, at the same time increasing the attraction for oxygen. The compounds of silver and gold are reduced by pyrogallic acid even more rapidly than by gallic acid, the reducing agent absorbing the oxygen and becoming converted into carbonic acid and a brown matter insoluble in water. Commercial pyrogallic acid is often contaminated with empyreumatic oil, and also with a black, insoluble substance known as *metagallic acid*.

Pyrogallic acid is used as being superior to gallic acid for the development of photographic pictures. The developing solution was originally made as follows, for negatives:

Pyrogallic Acid	3 grains.
Crystallizable Acetic Acid	1 drachm.
Distilled Water	1 ounce.

For positives:

Pyrogallic Acid	2 grains.
Nitric Acid	1 drachm.
Water	1 ounce.

There are many modifications. It cannot be used for developing without acetic or nitric acid, the use of acid being the principal resource in obviating cloudiness of the image. It is adapted for collodion, gelatine, and paper negatives. If the ordinary pyrogallic-acid developing solution be kept for some time, it becomes brown. In this state it will still develop the image, but is less likely to give a clear and vigorous picture. A solution of pyrogallic acid in acetic acid will keep for many weeks, and may be diluted with water as required for use. The acid solution may be 12 grains of pyrogallic acid to 1 ounce of acetic acid.

Pyrogallol. $C_6H_3(OH)_3$. Pyrogallic acid; pyro. Trihydroxybenzene. Pyrogallol, generally called pyrogallic acid or "pyro," is obtained by heating gallic acid to 400° F., when it is decomposed and the pyrogallol is condensed in thin lamellar crystals tufted together. Pyrogallol is white in color; readily soluble in water, alcohol and ether; in presence of an alkali its action is that of a powerful reducer of the salts of silver, upon which property its use in photography depends. It does not turn blue litmus red, and is bitter, not sour to the taste; hence pyrogallol is not reckoned a true acid by chemists. Aqueous solutions of pyrogallol abstract oxygen from the air and discolor rapidly, losing their reducing power thereby. To preserve pyrogallol in solution, and to retard its decomposition the addition of citric acid, sulphite of soda, or meta-bisulphate of potash is advised. A grain of the latter to each ounce of hypo solution acts as an excellent preservative.

In 1851, Liebig suggested the use of pyrogallol as a developer for wet collodion plates, and although iron protosulphate superseded it for this purpose, it is still used to re-develop (strengthen) the negative image in that process. It was also used with ammonia as a developer for tannin plates; and when gelatine dry plates were introduced it was found that pyrogallol was at once the most powerful and controllable developing agent available for these plates. Since that time it has held the first place among dry-plate developers, although latterly the popularity of the more modern agents, such as amidol, eikonogen, hydroquinone, and metol threatens its supremacy. (See *Pyrogallic Acid*, also *Developers* and *Development*.)

Pyroligneous Acid. Impure acetic acid obtained by the destructive distillation of wood in close vessels. It is used for the production of pure acetic acid.

Pyroligneous Spirit. Also known as pyroxylic spirit, and wood alcohol. A fluid resembling alcohol in many respects, but it belongs to the methyl series. Its use in the manufacture of collodion arises from its presence in "methylated spirit."

Pyroxylene. An orange-red crystalline substance obtained from pyroxylic spirit by adding potash water, pressing the precipitate, washing with cold alcohol of sp. gr. 0.840, and crystallizing from boiling alcohol.

Pyroxylin (Gun-Cotton). This substance is paper or cotton which has been altered in composition and properties by treatment with strong acids. Both cotton and paper are, chemically, the same. They consist of fibres which are found, on analysis, to have a constant composition, containing three elementary bodies—carbon, hydrogen, and oxygen—united together in fixed proportions. To this combination the term *lignin* or *cellulose* has been applied. Cellulose is a definite chemical compound in the same sense as starch or sugar, and conse-

quently, when treated with various reagents, it exhibits properties peculiar to itself. It is insoluble in most liquids and also in dilute acids, but when acted upon by nitric acid of a certain strength it liquefies and dissolves. When a body dissolves in nitric acid the solution is not usually of the same nature as an aqueous solution; and so in this case the nitric acid imparts oxygen first to the cotton and afterward dissolves it. If, instead of treating cotton with nitric acid, a mixture of nitric and sulphuric acids in certain proportions be used, the effect is peculiar. The fibres contract slightly, but undergo no other visible alteration. Hence we are at first disposed to think the mixed acids ineffectual. This idea, however, is not correct, since on making the experiment the properties of the cotton are found to be changed. Its weight has been increased by more than one-half; it has become soluble in various liquids, such as acetic ether, ether, and alcohol, etc., and what is more remarkable it no longer burns in the air quietly but *explodes* on the application of flame, with more or less violence. This change of properties clearly shows that although the fibrous structure of the material is unaffected it is no longer the same substance, and consequently chemists have assigned it a different name, viz., *pyroxylin*. To produce the peculiar change by which cotton is converted into pyroxylin both nitric and sulphuric acids are, as a rule, required; but of the two the former is the most important. On analyzing pyroxylin, nitric acid, or a body analogous to it, is detected in considerable quantity, but not sulphuric acid. The latter acid, in fact, serves but a temporary purpose, viz., *to prevent the nitric acid from dissolving the pyroxylin*, which it would be liable to do if employed alone. The sulphuric acid prevents the solution by removing water from the nitric acid, and so producing a higher degree of concentration; pyroxylin, although soluble in a dilute, is not so in the strong acids, and hence it is preserved. The property possessed by oil of vitriol of removing water from other bodies is one with which it is well to be acquainted. A simple experiment will serve to illustrate it: Let a small vessel be filled to about two-thirds with oil of vitriol and set aside for a few days; at the end of that time, and especially if the atmosphere be damp, it will have absorbed sufficient moisture to cause it to flow over the edge. Now, even the strongest reagents employed in chemistry contain almost invariably water in greater or less quantity. Pure anhydrous nitric acid is a white, solid substance; hydrochloric acid is a gas; and the liquids sold under these names are merely *solutions*. The effect, then, of mixing strong oil of vitriol with aqueous nitric acid is to remove water in proportion to the amount used, and to produce a liquid containg nitric acid in a high state of concentration, and sulphuric acid more or less diluted. This liquid is *nitro-sulphuric acid* employed in the preparation of pyroxylin.

Very soon after the first announcement of the discovery of pyroxylin most animated discussions arose among chemists with regard to its solubility and general properties. Some spoke of a "solution of gun-cotton in ether," whilst others denied its solubility in that menstruum; a third class, by following the process described, obtained a substance which was not explosive, and therefore could scarcely be termed gun-cotton. On further investigation some of these anomalies were cleared up, and it was found that there were *varieties* of pyroxylin depending mainly upon the degree of strength of the nitro-sulphuric acid employed in the preparation. Still the subject was obscure until the publication of researches by Mr. E. A. Hadow. These investigations, conducted in the laboratory of King's College, London, were published in the *Journal of the Chemical Society*. Pyroxylin has been sometimes spoken of as a salt of nitric acid, a *nitrate of lignin*. This view is, however, erroneous, since it can be shown that the substance present is not nitric acid, although analogous to it. It is the peroxide of nitrogen, which is intermediate in composition between nitrous acid (NO_3) and nitric acid (NO_5). Peroxide of nitrogen (NO_4) is a gaseous body of a dark-red color; it possesses no acid properties and is incapable of forming a class of salts. In order to understand in what state this body is combined with cotton fibre to form pyroxylin, it will be necessary to study the laws of combination (see *Equivalent*). Mr. Hadow has succeeded in establishing *four* different substitution compounds, which, as no distinctive nomenclature has been at present proposed, may be termed compounds *A*, *B*, *C*, and *D*. *Compound A* is the most explosive gun-cotton, and contains the largest amount of per-

oxide of nitrogen. It dissolves *only in acetic ether*, and is left in evaporation as a white powder. It is produced by the strongest nitro-sulphuric acid which can be made. *Compounds B* and *C*, either separate or in a state of mixture, form the soluble material employed by the photographer. They both dissolve in acetic ether, and also in a mixture of ether and alcohol. The latter, viz., *C*, also dissolves in glacial acetic acid. They are produced by a nitro-sulphuric acid slighly weaker than that used for *A*, and contain a smaller amount of peroxide of nitrogen. *Compound D* resembles what has been termed *xyloidin*—that is, the substance produced by acting with nitric acid upon starch. It contains less peroxide of nitrogen than the others, and dissolves in ether and alcohol, and also in acetic acid. The ethereal solution leaves on evaporation an opaque film, which is highly combustible but not explosive. By bearing in mind the properties of these compounds, many of the anomalies complained of in the manufacture of gun-cotton disappear. If the nitro-sulphuric acid employed is too strong the product will be insoluble in ether, whilst if it is too weak the fibres are gelatinized by the acid and partly dissolved. To procure nitro-muriatic acid of the proper strength is more difficult than would at first appear. It is easy to determine an exact formula for the mixture, but not so easy to hit upon the proper proportions of the acids required to produce that formula; and a very slight departure from them altogether modifies the result. The main difficulty lies in *the uncertain strength of commercial nitric acid*. Oil of vitriol is more to be depended upon and has a tolerably uniform specific gravity of 1.836; but nitric acid is constantly liable to variation; hence it becomes necessary to make a preliminary determination of its real strength, which is done either by taking the specific gravity and referring to tables, or, better still, by a direct analysis. As each action of sulphuric acid removes only a given quantity of water, it follows that the weaker the nitric acid the larger the amount of sulphuric which will be required to bring it up to the proper degree of concentration. To avoid the trouble necessarily attendant upon these preliminary operations, many prefer to use, in place of nitric acid itself, one of the salts formed by the combination of nitric acid with an alkaline base. The composition of these salts, provided they are pure and nicely crystallized, can be depended upon. Nitrate of potash, or *saltpetre*, contains a single atom of nitric acid united with one of potash. It is an anhydrous salt —that is, it has no water of crystallization. When strong sulphuric acid is poured upon nitrate of potash in a state of fine powder, in virtue of its superior chemical affinities it appropriates to itself the alkali and liberates the nitric acid. If care be taken to add sufficient excess of the sulphuric acid, a solution is obtained containing sulphate of potash dissolved in sulphuric acid and free nitric acid. The presence of the sulphate of potash (or more strictly speaking, of the bi-sulphate) does not in any way interfere with the result, and the effect is the same as if the mixed acids themselves had been used. The reaction may be represented:

Nitrate of potash + sulphuric acid in excess = bisulphate of potash + nitro-sulphuric acid.—*Hardwich*.

Among the numerous formulæ for making pyroxylin are the following:

I. Procure nitro-sulphuric acid, sp. gr. 1.42. Put some hot water into a pie-dish, and put it upon a stove in an open space or out-house. Put 4 fluidounces of the acid into a basin and set it in the dish of hot water; then *immediately*, and before the acid gets cold, put into these, in small quantities at a time, 80 grains of the best cotton-wool, previously pulled out into flat pieces. Stir it about well in the acids for five minutes with a pair of glass rods. Then quickly throw away the acids and put the gun-cotton into a pail of water; wash it well and quickly, and change the water a dozen times; wring out the gun-cotton between your hands. Lastly, let it soak in water twenty-four hours; then pull it out and spread it to dry spontaneously upon a piece of *white* paper. Be particular that the acid is sp. gr. 1.42, otherwise all will go wrong.

II. In a wide-mouth stoppered bottle introduce 14 to 17 ounces of sulphuric acid; add, in several portions, 1440 grains of powdered saltpetre; then 62 grains of fine cotton in small quantities at a time. Allow the whole to soak for about ten minutes, stirring constantly; then wash in eight or ten changes of water, and dry as before directed.

III. Mix in a Wedgwood basin, 20 fluidounces of sulphuric acid, sp. gr. 1.840; 13 ounces of pure nitrate of potash in powder,

stirring about one minute; then quickly immerse 5 drachms of best carded cotton, and stir it thoroughly. Cover it up with a piece of glass, and let it rest ten or twelve minutes. Then turn it out into a large quantity of water, and cause it to distribute itself quickly therein. Wash it in water, frequently changed, until no trace of acid is perceptible; finally dry it by extending it loosely over bibulous paper.

IV. Mix in the same manner as for III., 7 fluidounces of nitric acid, sp. gr. 1.425; 8 fluidounces of sulphuric acid, sp. gr. 1.840. Cut into strips 1 ounce or more Swedish filtering paper and *immerse* the strips one by one; cover up as before; within half an hour take out a small piece *from the middle*, quickly wash and dry it, and try its solubility in alcohol and ether. If not sufficiently soluble, let it remain ten minutes longer, and again try.

Q.

Qualitative Analysis determines the quality or nature of the ingredients of a compound without regard to the quantity of each present.

Quantitative Analysis is that branch of practical chemistry which treats of the processes by which the actual quantity of any constituent in a compound is determined.

Quantitative Testing of Silver Solutions. The amount of nitrate of silver contained in solutions of that salt may be estimated with sufficient delicacy for ordinary photographic operations by the following simple process: Take the *pure* crystallized chloride of sodium, and either dry it strongly or fuse it at a moderate heat, in order to drive off any water which may be retained between the interstices of the crystals; then dissolve in distilled water, in the proportion of 8¼ grains to 6 fluidounces. In this way a standard solution of salt is formed, each drachm of which (containing slightly more than ⅙ of a grain of salt) will precipitate exactly ½ a grain of nitrate of silver. In order to use it, measure out exactly 1 drachm of the bath in a minim measure, and place it in a 2-ounce stoppered vial, taking care to rinse out the measure with a drachm of distilled water, which is to be added to the former; then pour in the salt solution, in the proportion of 1 drachm for every 4 grains of nitrate *known to be present* in an ounce of the bath which is to be tested; shake the contents of the bottle briskly, until the white curds have perfectly separated and the supernatant liquid is clear and colorless; then add fresh portions of the standard solution by 30 minims at a time, with constant shaking. When the last addition causes no *milkiness*, read off the total number of drachms employed (the last half-drachm being subtracted), and multiply that number by four for the weight in grains of the nitrate of silver present in an ounce of the bath. In this manner the strength of the bath is indicated within 2 grains to the ounce, or even to a single grain if the last additions of standard salt solution be made in proportions of 15 instead of 30 minims. Supposing the bath to be tested is thought to contain about 35 grains of nitrate to the ounce, it will be convenient to begin by adding to the measured drachm, 7 drachms of the standard solution; afterward, as the milkiness and precipitation become less marked, the process must be carried on more cautiously, and the bottle shaken violently for several minutes, in order to obtain a clear solution. A few drops of nitric acid added to the nitrate of silver facilitates the deposition of the chloride; but care must be taken that the sample of nitric acid employed is pure and free from chlorine, the presence of which would cause an error.—*Hardwich.*

Quartz. A mineral; long, beautiful, six-sided crystals; very hard and transparent; as sharply defined as glass, allowing even the most refrangible rays to pass, which renders it especially serviceable for lenses for photographing the ultra-violet spectrum.

Quicklime. Quicklime is of a pure white color and earthy appearance. It corrodes animal and vegetable substances; has a burning, causting taste; attracts moisture and carbonic acid rapidly from the atmosphere, and is easily reduced to powder. It is obtained by exposing to a red heat carbonate of lime, by which means its carbonic acid is expelled. White marble yields the best and purest lime.

Quicksilver. (See *Mercury.*)

Quick-Stuff. A term applied to the accelerating compounds used in the daguerrean process.

Quinine. A white, odorless, bitter, fusible, and crystallizable alkaloid, discovered by Pellitier and Caventon in cinchona bark. It is most readily obtained by precipitating

a solution of the sulphate or disulphate by ammonia, and washing and drying the precipitate. By solution in alcohol, sp. gr. 0.815, and spontaneous evaporation, it may be procured in crystals. Crystals may also be obtained from its solution in hot water by ammonia.

Quinine, Sulphate of. Prepared by boiling bruised yellow cinchona bark, 7 pounds in sulphuric acid, 4 ounces, 7 drachms, diluted with 6 gallons of water; boil one hour and strain; repeat the boiling a second time for one hour, with a like quantity of acid and water, and again strain; next boil the bark in 8 gallons of water and strain. To the mixed liquors add moist hydrated oxide of lead nearly to saturation; decant the supernatant fluid, and wash the sediment with distilled water; boil down the liquor for fifteen minutes and strain; then precipitate the quinia by solution of ammonia and wash the precipitate with cold water until alkalinity is imperceptible; saturate what remains with sulphuric acid, ½ ounce, diluted with water, digest with animal charcoal, 2 ounces, and strain. Lastly, the charcoal being well washed, evaporate the mixed liquors that crystals may form.

Many very curious photographic phenomena have been found by experiments with sulphate of quinine. In order to gain a correct notion of the photographic value of the "invisible" chemical rays, as compared with those which are associated with the upper colored spaces, a simple plan is to select some medium which possesses the property of *absorbing* one set of rays and of permitting the other to pass; so that having sifted them out, as it were, the one from the other, we may be able to deal with each separately. Such a medium is distilled water holding in solution a large percentage of the *sulphate of quinine*. A solution of the sulphate of quinine immediately strikes the most casual observer as being in some way different from ordinary liquids; it is perfectly colorless and transparent, like water, but has a peculiarly silvery and blue tinge, when held in certain positions, hence it is easy to imagine that rays of white light are modified by passing through it. The nature of this modification is as follows: The elementary colored rays are all transmitted, consequently the fluid appears *colorless*, but *the most refrangible chemical rays* are absorbed. The white light which passes still possesses a certain amount of chemical action, but it is of that feeble kind which belongs more exclusively to the visible rays. To illustrate the relative value of the *visible* and *invisible* actinic rays, it has been found that a picture upon *bromidized collodion* requires, when the light has been previously sifted by solution of sulphate of quinine, an exposure of *forty minutes;* upon iodized collodion, without the quinine, *four minutes.* Therefore (supposing the sensibility of the two samples of collodion to have been equal), by the employment of all the rays the image was formed in exactly a tenth part of the time required when only the colored rays were used; in other words, the invisible highly refrangible rays which affect both bromide and iodide of silver alike, proved to be ten times more energetic than the colored chemical rays which decompose the bromides of silver proportionately more. Applying this to the production of landscapes by means of photography, what, it may be asked, would be the amount of effect produced by the green color of foliage, as compared with that of the other rays of white light? In point of fact, the picture might be taken *ten times over*, or thereabouts, by all the rays conjoined, before these color rays would have time to impress themselves.

Sulphate of quinine has the singular property of impressing an image of itself upon a sheet of paper in the dark. If you write upon a sheet of paper with a solution of sulphate of quinine, expose it for a short time to the sun's rays, and then press it upon another sheet of sensitive paper in the dark for some time, after removal it will be found that the writing has been faithfully copied. (See *Photo-Phosphorescence.*)—*H. H. Snelling.*

Quinolin. (See *Cyanine.*)

Quinolin-Red. A mixture of quinolin-red and cyanine-blue is obtainable commercially as *Azaline* (which see). Employed in orthochromatic photography as a sensitizer.

Quinol. (See *Hydroquinone.*)

Quinol Intensifier. In 1888 Capt. Hubl recommended quinol (hydroquinone) for intensifying collodion negatives, giving the following formula:

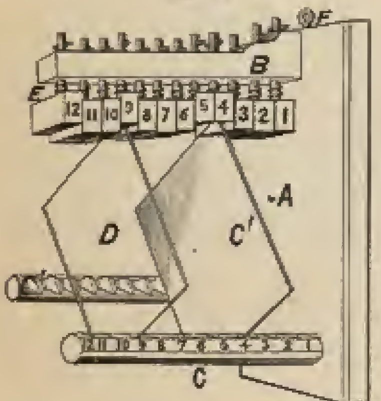
A.	Quinol (Hydroquinone)	10 parts.
	Citric Acid	6 "
	Water	1000 "
B.	Nitrate of Silver	1 part.
	Water	30 parts.

For use mix 3 ounces of A to 1 ounce of B.

R.

Rack or Plate-Stand. Used in making dry plates. A is a piece of wood to which the support B and the two legs C and C′ are glued. The support B has one dozen pegs which slide up and down with ease. A spring, E, should be supplied to each peg. On the two legs C and C′ are twelve notches

FIG. 170.



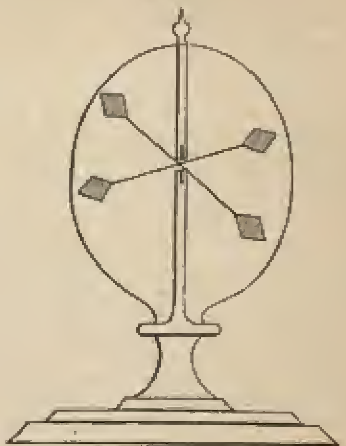
corresponding to the twelve pegs. A hook is supplied at F for hanging the apparatus upon the wall when the plates are ready to dry.

Rackwork. Rack and pinion; arrangements in objective and camera, admitting of exact focussing by means of micrometer screws and rod.

Radiation. The distribution or throwing off rays of light from luminous bodies.

Radiometer. An instrument measuring the actinic power of light. A radiometer devised by Mr. Crookes is of the form and size of a large swan's egg, and made of blown glass. In the centre is a pedestal of the same substance, and rising half-way up the egg. Another pedestal descends from the top and meets the lower one to within about an eighth of an inch. The two ends of these pedestals are hollow for about a quarter of an inch; the pedestals are employed, the lower one to support, the upper one to hold a light steel axis, to which is attached a kind of windmill sail, made of four pieces of very thin mica, a quarter of an inch square, and of exactly the same weight; one side of the mica is painted black and the other is silvered. This kind of four-sail mill is placed in perfect equlibrium between the

FIG. 171.



two pedestals or pillars, a vacuum is then obtained, and, what is extraordinary, if the apparatus be placed in sunlight, it will revolve with astounding rapidity; if put in the shade, it will turn slowly; if in the dark, it will remain stationary.

Raisin Extract. It is found in natural combination in the common raisin or dried grape.

Rapidity. The greater or less rapidity with which a lens produces the picture within the sensitive film depends mainly on the opening and focal length of the lens. It may be determined by dividing the square of the opening by the square of the focal length.

Rapidity of Lenses. A term by which is denoted the greater or less amount of time which a lens requires to allow the light to produce a developable image upon the sensitive plate. Rapidity depends chiefly upon the working aperture of the lens, which in turn depends upon the glass and manner of construction of the lens. For instantaneous or rapid work a lens should be used with a large angular aperture. The newer forms of lenses are, generally speaking, more rapid

than the old forms, on account of the glass employed in their construction and their improved form.

Ray. A line of light, or the right line supposed to be described by a particle of light; a collection of parallel rays constitute a *beam*; a collection of converging or diverging rays, a *pencil* of light. (See *Light*.)

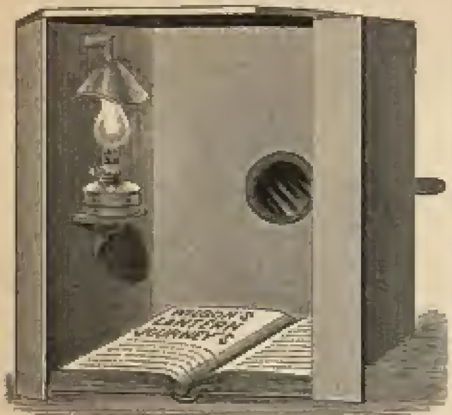
Reading-Glass Stereoscope. If we take a reading-glass whose diameter is not less than 2¼ inches, and look through it with both eyes at a binocular picture in which the right-eye view is on the left hand, and the left-eye view is on the right hand, as in the ocular stereoscope, we shall see each picture doubled, and the degree of separation is proportioned to the distance of the picture from the eye. If the distance of the binocular pictures from each other is small, the two middle images of the four will be united when their distance from the lens is not very much greater than its focal length. With a reading-glass 4½ inches in diameter, with a focal length of 2 feet, binocular pictures, in which the distance in similar parts is *nine* inches, are united without any exertion of the eyes at the distance of 8 feet. With the same reading-glass, binocular pictures at the usual distance of 2½ inches, will be united at the distance of 2¼ or even 2½ feet. If we advance the reading-glass when the distance is 2 or 3 feet, the picture in relief will be magnified, but, though the observer may not notice it, the separated images are not kept united by a slight converging of the optic axis. Although the pictures are placed so far beyond the anterior focus of the lens, they are exceedingly distinct. The distinctness of vision is sufficient, at least to long-sighted eyes, when the pictures are placed within 16 or 18 inches of the observer—that is, 6 or 8 inches nearer the eye than the anterior focus of the lens. In this case we can maintain the union of the pictures only when we begin to view them at the distance of 2½ or 3 feet, and then gradually advance the lens within 16 or 18 inches of the pictures. At considerable distances the pictures are most magnified by advancing the lens while the head of the observer is stationary.

Read's Gutta-Percha Process. This is a process in which gutta-percha is substituted for glass, and is the invention of the Rev. J. B. Read. Dissolve gutta-percha in benzole or chloroform, 30 grains to the ounce, by immersing the bottle containing the ingredients in hot water. Pour this solution upon a plate of glass, draining off the excess, and dry quickly by holding it over a spirit lamp, or some other source of heat. The film adheres perfectly to the glass, and it has no tendency to separate from it on subsequent immersion in the nitrate bath if the edges of the glass are roughened; but if, as in common cases, they are smooth and polished, it is advisable when the film is dry to secure it firmly and certainly by passing the four edges of the coated glass through the flame of a spirit lamp. By this method about one-eighth of an inch of the film is dissolved, or nearly so, all round the surface of the glass, and no separation can be produced by any amount of immersion in water. This film, now firmly fixed upon the glass, is treated in the subsequent process as if it were glass. The iodized collodion is poured upon it and sensitized in the usual way, and the picture is taken, developed, fixed, and varnished. The point of a knife is now carried around the edge of the glass for the purpose of scraping off the small portion of the film which had been semi-dissolved by heat to secure its perfect adherence. It is then placed in water for a minute or two, one edge of the film is slightly raised so that the finger can take hold of it, and the whole separates with great facility and floats. By raising the glass up to it it can be taken out on its surface, placed with the film downward upon blotting-paper, and the glass drawn from it. When dry, place the film between two pieces of paper, hold it up to the light and cut the paper, and at the same time the film, which is perfectly visible through the paper, to any required size. We have now a negative ready for the printing-frame, taken on a material as durable and manageable as glass, but occupying but a small portion of its space, and perfectly free from the peculiar risks so often destructive to valuable negatives. In consequence of benzole having the property of becoming solid at a temperature of 32°, the gutta-percha dissolved in it, unless it be a very thin film, has a tendency to become opaque, which might possibly interfere with the subsequent printing from the negative. This defect is wholly avoided by dissolving the *benzole film*, when dry, in chloroform, and then using the chloroform film, which never becomes opaque, for the purpose proposed.

Reaumur. (See *Thermometer*.)

Reading-Lamp. This convenient arrangement is for the use of lecturers when

Fig. 172.



using the magic lantern. In the front there is a color disk attached to the lever shown at the right. When the lecturer desires a change of slide he signals to his operator by the use of this lever, the disk raising or lowering with it. The position of the lamp and the notes of the lecturer are shown by the figure.

Ready-Sensitized Paper. To prepare sentitized albumen paper which will keep, float the paper three minutes on

Nitrate of Silver	100	parts.
Citric Acid	400	"
Water	1200	"
Alcohol	100	"

After each sheet has been sensitized 10 parts of the following solution are added to the bath:

Nitrate of Silver	20	parts.
Citric Acid	15	"
Water	200	"
Alcohol	20	"

When removed from the bath the paper is drawn over a glass rod, and, after draining, placed with the sensitized surface on chemically pure blotting-paper. It is then covered on its back with a sheet of stout paper, and well and evenly wiped off by powerful rubbing and pressing. Finally, it is allowed to dry in the dark. If placed between preserving paper it will keep for from six to eight weeks in summer, and for months in winter. The preserving paper consists of soft, very thick, unsized blotting-paper of white color, which should be entirely free from wood, chemically pure, and saturated with carbonate of soda. It should be used in rolls of from five to six yards in length, and kept together with the sensitized paper in pasteboard or tin boxes.

Reagent. A substance employed to detect the presence of bodies in other substances.

Receiving Surface. The surface used to receive the sensitive coating for the production of negative or positive photographs.

Recovery of Silver from Waste Solutions. All solutions of silver should be preserved, and when a sufficient quantity has been accumulated it should be sent to a refiner. (See *Wastes*.)

Rectification. The process of refining or purifying any substance by repeated distillation, which separates the grosser parts. To render a substance purer by separating an operation which it has already undergone.

Rectifying the Bath. The nitrate bath frequently gets out of order in consequence of the introduction, from various causes, of foreign matters. In this state it works badly; but the difficulty may be obviated by turning the solution into a glass bottle, placing it for some hours in the sun. A purplish-black or brown precipitate will be formed, which must be filtered out, and the bath is again ready for use. If time is an object, the bath may be filtered through kaolin as soon as it begins to dissolve. Boiling is also a good remedy.

Rectilinear Lens. That form of objective which will give images of parallel lines in all parts of the picture without distortion. (See *Lens*.)

Re-develop. To strengthen a negative picture by repeating, after fixing, the developing process.

Re-developer. The combination by which to re-develop the negative picture. (See *Re-developing Solution*.)

Re-development. In wet collodion photography the negative image is sometimes developed twice; the second development is essentially intensification, and is called re-development.

Re-developing. The act of strengthening a negative picture by means of the re-developing solution. After the negative is fixed and cleared up in the hyposulphite bath, and

well washed, the developer is poured on and off until the desired strength or intensity is obtained; it is then thoroughly washed again and set up to dry. (See *Intensifying*.)

Re-developing Solution. The mixture or solution with which a negative is intensified. To prepare this solution take: 1. The developing solution, whether o protosulphate of iron, or pyrogallic acid, and add to it about 10 drops to the ounce of a 20-grain solution of nitrate of silver; or 2. Dissolve 1 ounce protosulphate of iron in 16 ounces of water; add 4 ounces acetic acid No. 8 and 1 ounce alcohol, and make separate a 20-grain solution of nitrate of silver; first pour on the iron solution, and then the silver, and repeat the operation alternately until the desired strength is obtained; or 3. Make a solution of

Pyrogallic Acid	2 grains.
Water	1 ounce.
20-grain solution Nitrate of Silver	20 drops.

Red Fog. A fault in the negative, consisting of a darkened deposit, seen by transmitted light in the shadows.

Red, New. A name sometimes given to nitrate of rosaniline, used in orthochromatic photography.

Red Salt. The name given by the Platinotype Company to potassium chloroplatinite. (See *Chloro-Platinite of Potassium*.)

Reducer. The liquid by which the density of a negative is reduced.

Reducers. If a gelatine dry-plate becomes too dense for after-treatment in development, the deposit or image must be reduced in intensity. Combinations of substances which reduce this intensity, either in negatives or positives, are called reducers. Several formulæ are given for this purpose, of which the first is most generally commended.

Dr. J. J. Higgins' Formula.

Take neutral oxalate of potash, 375 grains, and dissolve it in three ounces water. Add sulphate of iron and ammonia, 146 grains, previously dissolved in one ounce of water. Mix thoroughly and set aside in a dark room until complete evaporation has taken place. A dry green salt will be left, in weight about one ounce.

To make the reducer, dissolve (thoroughly) the green salt in eight ounces of water, and add eight ounces of a saturated solution of hypo soda (hypo, one pound; water, a pint and a half). Filter well and keep excluded from light and air.

C. J. Leaper's Formula.

Potassium Cyanide	½ ounce.
Water	10 ounces.

Dissolve and add

Bromine Water	2 drachms.

This is an excellent mixture for local or complete reduction. It is, however, deadly poisonous, and should be kept under lock and key when not in use.

Ferric Chloride Reducer.

Ferric Chloride	1 drachm.
Water	1 ounce.

Immerse in the above, and then return the plate to the fixing-bath.

Farmer's Reducer.

Potassium Ferricyanide	3 grains.
Hypo	30 "
Water	4 ounces.

N. B.—Burton has lately advocated more dilute solutions for reduction of over-printed silver positives on paper.

Bachrach's Reducer.

Use equal proportions of a saturated aqueous solution of bichloride of mercury, and of a solution of 12 grains of cyanide of potassium in 1 ounce of water. In all cases the negative should be well washed and cleared before and after reduction.

Reducin. A developer introduced in 1893, of the same class as amidol, metol, etc., said to be the hydrochloride of diamidoresorcin. Reducin acts as an energetic developer for dry plates without the addition of an alkali. Commercially it appears as a whitish mass of loose cystals in needles. Dr. Vogel suggests the following formula:

Reducin	3 parts.
Sodium Sulph. (cryst.)	25 "
Sulphuric Acid	9 drops.
Water	500 parts.

Reducin is said to have double the developing power of pyro-soda: *i. e.*, it develops the same image with only half the exposure needed for pyro-soda development, and the resulting negatives are softer and more harmonious in gradation than with pyro-soda.

Reducing Agents. Substances the application of which to the exposed film render the latent picture visible, in other words develop it. In the gelatine bromide of silver process the reducers are used in an alkali solution, with the exception of the oxalate of iron and amidol developers. The usual alkaline reducers are: eikonogen, hydroquinone, hydroxylamine (muriate), paramidophenol, pyrogallic acid, metol.

Reducing Liquid. The developer; developing solution.

Reducing Over-Printed Aristotypes. An old hypo bath, to which a few drops of a saturated solution of ferrocyanide of ammonia have been added, is said to be an excellent reducer for over-printed aristo prints and also for prints on gelatino-bromide paper.

A writer in *Photo. Nachrichten* says that the reducer given above may be greatly improved by the substitution of rhodanammonium for the hypo. Rhodanammonium being much more readily washed out of the prints than hypo, much time and trouble may be saved by its substitution. The working formula is as follows:

Ferrocyanide of Potassium . . .	5 parts.
Rhodanammonium (or Sulphocyanide of Ammonium) . .	10 "
Water (distilled)	500 "

Afterward thoroughly wash the prints.

Reduction. The operation by which the oxides of metals pass to the *metallic* state.

2. *Reduction.* The act of reducing the intensity of negatives by chemical or mechanical means, to make them print more quickly.

Reduction of Silver Salts. Oxide of silver is reduced to the metallic state by first dissolving it in aqua ammoniæ (forming the ammonio-nitrate of silver) and adding solution of sulphate of iron. A precipitate settles at the bottom which is metallic silver. The *oxy-acid* salts, which contain the oxide of silver immediately combined with oxygen acids, such as the nitrate, acetate, and sulphate of silver, are readily reduced by the developing agents in the same manner as the oxide of silver, but more slowly. The presence of an acid united with the base is a hindrance to the process and tends to keep the oxide in solution, especially when that acid is powerful in its affinities. The precipitate of metallic silver, obtained by action of reducing agents upon the nitrate, varies much in color and general appearance. If gallic or pyrogallic acid be employed, it is a black powder; whilst the salts of iron, and especially the same with free nitric acid added, produce a sparkling precipitate, resembling what is termed *frosted silver.* Grape sugar and many of the essential oils separate the metal from ammonio-nitrate of silver in the form of a brilliant mirror film, and are often employed in silvering glass. In the reduction of *hydro-acid salts,* which contain no oxygen or oxygen acids, but simply elements like chlorine or iodine combined with silver, an *atom of water,* composed of oxygen and hydrogen, takes a part in the reaction. The oxygen of the water passes to the developer, the hydrogen to the chlorine.

To reduce *chloride of silver* to the metallic state, the salt must be first carefully washed several times with water, each time drawing or pouring off the water after the chloride has settled. It is then to be dried by gentle heat, and lastly, fused in a crucible with twice its weight of dry carbonate of potash, or with a mixture of carbonate of soda and potash. Or it may be done in the "moist way:" Wash the chloride as before, place it in a large flat dish and place a bar of zinc in contact with it. A small quantity of sulphuric acid, diluted with 4 parts of water, is then added until a slight effervescence of hydrogen gas is evolved. The vessel is set aside for two or three days, and must not be disturbed. When the mass has become of a gray color, the bar is to be carefully removed and the adhering silver washed off with water. In order to insure the purity of the silver, a fresh addition of sulphuric acid must be made after the bar has been removed, and the digestion continued for several hours, in order to dissolve any fragments of zinc which may have been inadvertently detached. The gray powder must be repeatedly washed, first with sulphuric acid and water, and then with water alone, until the liquid runs away *neutral* and gives no precipitate with carbonate of soda. It may then be fused into a button.

Reduction of Wastes. A process by which the silver in unfixed paper clippings and the sulphide and chloride of silver in old baths and wash-waters is reduced and saved. Gold also can be precipitated from old toning-baths by the addition of sulphate of iron.

Reflect. To throw back light, heat, etc.; to return rays or beams of light.

Reflecting Camera. Professor Draper was the first to use a camera of this description. At one end of a box is placed an elliptical mirror. The prepared plate is fixed to a sliding frame by which it is adjusted to the best focus. The rays of light, radiating from a figure, fall on the mirror, and are thence reflected to the plate. The mirror has the advantage of throwing a greater quantity of light upon the plate, but it has the great disadvantage of limiting the size of the picture. With a mirror of 7 inches diameter, we only procure pictures which will be perfect over 2 square inches; whereas, with a lens of 3 inches diameter and 14 inches focal length, pictures of a foot square may be worked. From this it will be seen that the mirror is only applicable where single objects are to be copied.

Reflecting Stereoscope. There are three kinds of reflecting stereoscopes. (1) The single reflecting; (2) the double reflecting; (3) the tubular reflecting. This form of the stereoscope was the discovery of Professor Wheatstone and was the original application of stereoscopy to binocular vision.

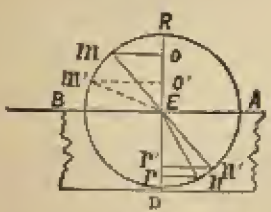
Reflection. The glancing of a light-ray from a polished plane. Only part of the light is thus reflected; the rest is diffused or absorbed. The law controlling reflexion is called catoptric.

Refract. To break the natural course of rays of light and turn or bend them from the direct course.

Refracting Medium. Any substance which refracts rays of light passing through it.

Refraction. This property of light was discovered in 1621, by W. Snell, and elevated optics to a positive science. If a ray of light, *R* (Fig. 173), falls perpendicularly upon a plane surface of a piece of glass, *A B*, it enters the glass without changing its course, in a straight line, *R D*; it only changes its velocity. But if a ray, *m*, strikes the surface at *E*, obliquely, it is refracted to *n*. A ray *m'*, is refracted to *n'*. Now if we erect perpendiculars from the points *m* and *n*, and also from the points *m'* and *n'*, to the normal *R D*, and divide the length, *o m* by *n r* and also divide *o' m'* by *n' r'*, we will have in both cases the same quotient; or, as it is generally expressed, the sine of the angle of incidence divided by the sine of the angle of refraction is a constant, whatever the angle of incidence may may be. This constant quota is called the index of refraction.

FIG. 173.



Refrangible. Capable of being refracted or turned out of a direct course in passing from one medium to another.

Refrangibility. The disposition of rays of light to be refracted or turned out of a direct course in passing out of one transparent body or medium into another.

Regeneration. Restoring the energy of, for instance, old, spoiled oxalate of iron developer by oxalic acid, bicarbonate of potash, and powdered sulphate of iron. (Lagrange.)

Release. Releasing the instantaneous shutter. This may be done by pneumatic action (tripod cameras) or by pressing a button, or by slowly raising the shutter-slide by means of a string. The two last methods are suitable for hand-cameras. In scientific work, the release is effected by electricity occasionally. The main point is not to jar the camera.

Relief Pictures. Pictures having the property of appearing raised, as if convexed or engraved; stereograms.

Rembrandt Lighting. A manner of lighting by which the head of a person receives one-fourth light and three-fourths shade, the light coming more or less from behind.

Removal of Silver Stains. First, for the hands, rub with a moderately strong solution of iodine in alcohol, either with a piece of sponge or a brush; then rinse in water, and afterward dip or rub with a weak solution of ammonia, or wash with chloride of lime, rubbing with a piece of cloth or brush. For linen, use the iodine solution and then dip in a weak solution of cyanide of potassium. If the stain is partly caused by gallic acid, a yellow stain will remain, which must be removed by soaking for a few hours in a solution of binoxalate of potash.

Removing Colored Fogs. To remove the colored veil or fog which occurs during development, especially with pyro, when the operation is prolonged, steep the negative for from five to ten minutes in water and make sure that it has been freed from all the hyposulphite of soda. Plunge it quickly into the following solution:

Cold Water . . .	1000 c.c.
Bromide of Sodium	5 grs.
Bromine . . .	3 "

This mixture should be made in a well-stoppered bottle and in a well-ventilated room to escape from the irritating vapors of the bromine. The image is allowed to whiten; it is even well to prolong the immersion slightly beyond the complete whitening. If the evaporation of the bromine is too rapid, or if the plate is very old, the solution should be renewed. Wash with care from five to ten minutes, then expose to the air for the same time so that the bromine may be completely evaporated. Then develop the plate with:

Water	250 c.c.
Sulphite of Soda	25 grains.
Amidol	1.50 grain.

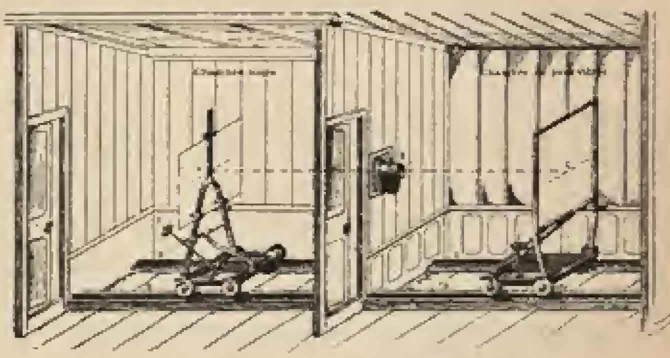
The operation is ended when the black color has been reached and plainly visible on the glass side of the plate. There is no objection to prolonging the time in the developing bath, the print being neither strengthened nor weakened by this treatment.

Repairing Broken Negatives. Where the film is still uninjured, it should be stripped and placed upon a new plate of glass. If, however, the film is broken, paste gum-paper in strips around the edges of the negative on both sides, allow to dry thoroughly, then varnish it on both sides. In printing, suspend the frame from a wasting-jack, or place it to print in a box 18 inches deep, open at the top.

Another plan is to squeegee the broken negative, carefully, to a gelatinized plate, then block out the background with Gihon's opaque, or Strauss' marl, spotting the prints should marks appear upon the printed image in the finished picture.

Reproduction of Drawings. The engraving is to show a method of enlarging or reducing drawings, proposed by Motteror.

Fig. 174.



The drawing is placed on the plate C, and the surface, A, is placed on the support. The movable frames roll on divided rails, D, which allow them to be stopped and fixed with the aid of the wheels, E, which command the stops of each of the frames. According to the relative speed of the frames and their respective distances from the objective, B, we obtain a reduction or enlargement of the desired scale. Wet collodion is best.

Reserves. A term proposed by M. l'Abbé Laborde to designate those parts of the proof upon which the light has not acted; and it will be found very convenient, as it designates without confusion similar effects by the same word, now known as the *whites* of the negative proof, and the *blacks* in the positive upon glass.

Residual Liquids. In photography, those liquids or solutions which, having been used, are no longer of any use in the process. These liquids should be preserved and treated for the silver they may contain. (See *Recovery of Silver from Waste Solutions.*)

Residues. The fine metals contained in paper-clippings, films or liquids (photographic waste), which may be refined by chemical process. According to Girard and Davanne only 3 per cent. of the originally employed silver is present in the finished paper-photograph, 7 per cent. in the dripping

and wiping-up papers and filters, 50 to 55 per cent. in the washing waters before toning, 30 to 35 per cent. in the fixing-bath, 5 per cent. in the wash-water after fixing.

Resin, Dry Process. A process in which a resinous oil is applied to the collodionized plate as a preservative, but upon which very little reliance can be placed.

Resin Soap. A product of a solution of resins in alkalies. Soluble in water. With a surplus of alkali, it gives on the addition of an acid a fine resinous precipitate, which, in the presence of gelatine emulsifies perfectly, making a splendid sizing for paper, closing up its pores after drying, thus obviating the sinking in of the picture.

Resorcin. $C_6H_4(OH)_2$. White prismatic crystals, of bitter-sweet taste, soluble in water, alcohol and ether. Resorcin and pyrocatechin are isomeric (of like composition but differing in appearance and properties) with hydroquinone. It has been tried as a developer, but its reducing power is but small.

Restoring Faded Prints. Dealing with this problem, Dr. J. H. Janeway writes: "Remove the print from the mount, soak in water, and immerse in a solution of neutral chloride of gold and potassium (3 to 4 grains of gold to 4 ounces of water) till the desired tone is obtained. Wash in subdued light; clear and wash carefully again. H. Sandareck received a medal from the Photographic Society of Vienna for the process of restoring albumen prints that have faded. His baths are: No. 1. Tungstate of soda, 100 grammes, or 3½ ounces; distilled water, 5000 cubic centimetres, or 175 ounces. No. 2. Carbonate of lime (C. P.) 4 grammes, or 62 grains; chloride of lime, 1 gramme, or 15½ grains; chloride of gold and sodium, 4 grammes, or 62 grains; distilled water, 400 cubic centimetres, or 12 ounces. Solution 2 is made in a yellow glass bottle, well stoppered, and allowed to stand for twenty-four hours before use. It is then filtered into another bottle of yellow glass, and, to preserve it, well corked. To use, say for a sheet of albumen paper, take 150 cubic centimetres, or 5¼ ounces of No. 1, to 4 to 8 cubic centimetres, or 1 to 2 drachms, of No. 2. These prints, well washed, are placed one at a time in this bath. The strengthening must not be too rapid, ten minutes being sufficient in summer, and the bath must not contain an excess of chloride of gold. Properly used, a beautiful, clear purple color is obtained. To clear the prints, take 150 cubic centimetres, or 5¼ ounces of solution No. 1, to 15 cubic centimetres, or 4 drachms of hypo soda. The strengthened prints are well washed, placed in this bath, one at a time, and soaked until the yellow color disappears, which requires, in some cases, 3 hours, when they are thoroughly washed."

Restoring Weak Negatives. Mr. W. E. Debenham recommends the following solution for the purpose of restoring printing force to negatives which have faded after mercurial intensification:

Schlippe's Salt	10 grains.
Water	1 ounce.

Wet the film thoroughly by soaking in a dish of water, and immerse in the restoring solution until the desired effect is obtained.

Restrainer (Retarder). A substance, which when added to the developer, protracts its action or effect. In the gelatino-bromide of silver process bromide of potash or ammonia, as also citric or acetic acids, or their respective salts are employed; in the wet collodion process acids, gelatine and certain organic substances are used. They prevent the precipitation of silver in those parts of the sensitive plate on which the light has not acted.

Reticulated Collodion. Collodion is said to be reticulated when, after being spread upon the glass plate, it forms crape-like markings in the film. These are caused by the collodion being defective, or from using too small a quantity in coating, in consequence of which the ether evaporates too rapidly. Collodion producing reticulation may often be corrected by adding to each ounce 8 or 10 drops of chloroform.

Retouching. Improving negatives and prints by covering flaws, by proper distribution and treatment of light and shade, and increasing brilliancy.

Negative retouching is usually accomplished with lead-pencil, but also with needle, water color, pastel, crayon, etc.; positive retouching refers to small prints which require spotting out with pencil or water colors, and enlargements which require finishing in crayon, water colors or pastel, etc.

Retouching Frame. Used by photographers when retouching negatives. It consists of a ground-glass on which the negative is placed; a silvered mirror working on pivots, so as to enable one to change its posi-

tion and reflect the light wherever wanted; (this latter is a great advantage, for the light can be intensified on any part of the negative) a shield for the eyes; and a frame or stand bearing the whole. When not in use the supporting rods are folded in, and the whole shuts up compactly, which keeps it always clean. A rest for the arm, to slide up and down, and an adjustable support for the negative are needed. In use the frame is set on a table at a north window if possible. The sun should never shine on it. Faber's pencils, F FB and B brands, are best. Several forms are sold in the trade.

Retouching Varnish. (See *Varnishes.*)

Reversal of the Negative Image. There are several methods by which the image may be converted into a positive instead of a negative image. Ordinary gelatine plates, if very much over-exposed, will yield a positive image upon development. Col. J. Waterhouse has experimented much in this direction, and says that when a small quantity of phenyl-thiocarbamide is added to the eikonogen developer and used in the development of gelatine plates correctly exposed, positive images may be obtained with certainty. The formula is given as follows:

A.	Eikonogen	5 parts.
	Sodium Sulphite	10 "
	Water	100 "
B.	Sodium Carbonate (cryst.)	4 "
	Water	100 "
C.	Phenyl-thiocarbamide	1 part.
	Water	2000 parts.

The developer is formed by taking 1 part of A, 2 parts of B, 1 part of C., to which is added 1 part of a 10 per cent. solution of potassium bromide, and, if the contrasts are too strong, a few drops of ammonia.

Col. Waterhouse states in a further communication that the tetra-thiocarbamide ammonuim bromide compound salt gives better results than the plain thiocarbamide. Another plan is to develop the image until it appears at the back of the plate; it is then placed in potassium iodide, 1 to 2 parts; potassium bromide, 10 parts; water, 100 parts. The plate is afterward washed and re-developed with pyro or ferrous oxalate in the usual way.

Reversed Negatives. In certain processes it is necessary that the negative image should be in a reversed position. This reversal may be obtained in various ways: (1) by the use of a prism of solid glass fitted to the hood of the lens, so that the image is reflected upon the ground-glass in a reversed position; (2) by the use of a mirror in place of the prism; (3) by exposing the plate through the glass, making allowance for the thickness of the glass in focussing; or (4) by stripping the film (unvarnished) from the plate and remounting it on a second plate in the desired position. This last is the most commonly followed method, and is given as follows:

There are three solutions required, viz.: The rubber solution, which can be purchased ready for use or made by dissolving a piece of Para or other gum in benzine; plain collodion, rather thin; and a solution of acetic acid and water 1:5.

The negative is made in the usual way, preferably on a plate much larger than the copied drawing will be, intensified with mercury or copper sulphite, and allowed to dry. It is then coated with the rubber solution (draining the surplus back into the bottle), placed on a slab or table, and allowed to dry. It is then coated with the collodion. Now, with a knife or some sharp instrument, cut through the film, leaving a margin of an inch around the picture. It is then placed in a bath containing the acidified water, where it remains for a few minutes. Another water bath, containing the clean plate which is to receive the film, is now got ready. The plate to be stripped is removed from the acid solution, washed gently under the tap, when, by trying the edges, it will be seen whether the film is ready to strip easily. If not, it must be replaced in the acid. When the edge of the film leaves the plate easily then lay the plate down, elevate one end of the bath, and starting at one corner gradually lift the film from its support until the other corner can be grasped and the film entirely removed. Then place in the dish containing the plate to receive it, face down, of course. Then by lifting the plate from the water, and with it the film, it will be found to cling to it, and to be quite free from air-bells or particles of dirt. Should the air-bells appear, they can be rubbed out with a soft piece of cotton or a squeegee, interposing a piece of clean absorbent paper.

Rice Glue. This is an elegant cement, very easy to manufacture, and is not only applicable to mounting photographs and all the purposes for which flour paste is used, but when reduced with water to the consist-

ency of clay it can be employed for models, busts, etc. It is made by mixing rice flour intimately with cold water, and then gently boiling the mixture; it is beautifully white, and when dry is semi-transparent, having the appearance of mother-of-pearl; it will take a high polish, and is very durable. Papers pasted together with this cement will sooner separate in their own substance than at the joining.

Ripening. A state of rest during which gelatino-bromide of silver emulsion mixed with ammonia, but little sensitive when first prepared, assumes the necessary sensitiveness. It requires usually twenty-four hours.

Rising Front. A movable piece of wood or front board fitted to the camera, which can be moved up or down to include more or less of the foreground of a subject as desired.

Rives Paper. Photographic raw paper made in Rives near Grenoble, and used for the preparation of sensitized paper.

Rochelle Salts. $C_4H_4O_6KNa$. Large colorless crystals; soluble in water but with difficulty in alcohol; decomposes in warm air slowly. Formerly recommended for use in the preparation of gelatino-chloride of silver.

Rocker. A developing dish connected with a pendulum, which when set in motion automatically rocks the tray, giving the operator leisure to tend to other things during development.

Rockers for Dishes. (See *Oscillating Tables*.)

Rock-Salt. In some localities common sodium chloride (salt) occurs in beds in a solid mass. This form is called rock-salt.

Rodinal. A concentrated solution of paramidophenol (which see). Recommended as an energetic developer for gelatine dry plates.

Rollason's Transfer Process. Having thoroughly cleaned the glass plate, coat it with iodized collodion or any photographic film analogous to it, sensitize it, take the picture, and develop and fix in the ordinary manner. The picture thus taken is subject to the improved process of Mr. Rollason for transferring from the glass. Having ascertained that it is perfectly dry, the inventor proceeds to color it (if intended to be colored) at the back, or on the film itself, in the following manner, employing oil or varnish, or well-sized water colors. The picture is tinted according to taste, and when dry, the whole is covered with any colored varnish, according to the general tint wished to be produced. If it is not desired to color the picture while on the glass, it is covered at once with varnish, the components of which are asphaltum, or Brunswick black, dissolved in mineral naphtha to about the consistency of cream. Its tone may be varied by the introduction of warmer or cooler color, according to taste, when the varnish is sufficiently dry, which may be proved by the finger detecting no stickiness. It is not desirable to let it dry beyond this point, lest it should crack; but in case further operation should be suspended for a time, to avoid cracking, the varnish must be coated with a thin solution of shellac, which will prevent further hardening of the varnish. The next proceeding is to remove the film from the glass; and having prepared a mucilage—composed, by preference, of gum-arabic and honey, in the proportion of 2 parts of the former to 1 part of the latter—the patentee covers the varnish with this mucilage (in case it be paper employed for the transfer, it may be necessary to dampen it first, and then coat it with the same mucilage), after which he attaches the paper or other flexible material to the back of the picture. An even adhesion of the surface is effected by dampening the edges between two pieces of wood jointed together, and rolling out the air-bubbles with a simple apparatus consisting of a piece of thick India-rubber tubing slipped tightly over an ordinary ruler. When the transfer is to be taken on wood, stone, or other non-flexible substances, care must be taken that the surface be perfectly smooth; and the air-bubbles may be excluded by applying one end of the picture first and gradually sliding it on. When the mucilage is dry enough, which may be ascertained by raising or bending back one corner of the picture, upon which, if sufficiently dry, the film should begin to separate itself from the glass, the time has arrived for completing its removal. By means of a feather, a few drops of water or spirits of wine are now introduced between the edge of the picture and the glass, and, at the same time, the separation is gradually effected. The transfer is now complete; and when it is desired to color or get rid of the iridescence that will be perceptible upon it, a little megilp, oil, or any other softening matter that will not injure the delicate surface is rubbed over it with a

pellet of cotton-wool, so as to leave a slight stickiness, to which the dry colors known as "mansions," and many other dry colors, will adhere; and in some instances, omitting this last operation, water, oil, or varnish colors may be employed. By the same means the transfer from a plate of glass of a plain film of collodion or albumen on to any suitable base, such as a sheet of paper, or linen, wood, or ivory, may be effected.

Roller-Blind Dark-Slide. A carrier or shield, whose slide is made of a number of strips of wood fixed on leather; when drawn, it remains within the shield. Used in larger cameras mostly.

Roll-Holder. For greater facility in the use of films, a roll-holder invented by Messrs. Eastman and Walker is used. At one end of the holder a roll of film is inserted, and its loose end drawn across and fastened to a roller on the other side. After the first exposure is made a light and peculiar system of machinery within the holder is then wound up, and set in motion. Thus, the film is drawn across the face of the holder until a given signal is sounded, when the works halt, and the film is ready for another exposure, and so on to the end of the film. A method of registering the exposures is supplied, and a puncture is made in the film automatically, as the film moves from roller to roller, to show where one exposure ends and another begins. The drawing (Fig. 175) makes it very plain. It consists

FIG. 175.

essentially of a metal frame carrying the spool wound with the supply of paper, and a reel for winding up the exposed paper, suitable devices for maintaining a tension upon the paper, and measuring and registering mechanism. The frame is hinged at both ends to the panelled board which forms the back of the enclosing case. The cut shows the holder with the case partly raised.

Rolling. A process which imparts to a photograph the necessary smoothness and suitable surface. A roller press is used for this purpose, in which a polished steel plate runs between two rollers. Burnishers are now generally used, in which a polished metal plate is heated as hot as flat irons usually are. They are mostly used for smaller work, such as cabinets and *cartes de visite*.

Roman's Taupenot's Process. The plates are prepared by the original collodion-albumen process; the collodion being bromo-iodized, and the albumen containing chloride, bromide, and iodide of cadmium. The collodion is spread, sensitized, and washed thoroughly; then coated with the albumen, and again excited in a bath of 35 grains of nitrate of silver to the ounce, and 30 minims of glacial acetic acid; and after again washing is coated with a 2-grain solution of gallic acid, and dried. The modification of M. Roman consists in using the developer hot. (See *Taupenot's Dry Process.*)

Rosaniline Nitrate. A nitrate of rosaniline is often sold as rubine, azaline (which see), new red, and fuchsin. Used in orthochromatic photography.

Rosaurin. This is frequently sold as aurin, and possesses similar properties. It is employed to dye non-actinic fabrics for dark-room windows, and to stain collodion for use in backing plates to avoid halation.

Rotating Diaphragm. A metal plate fixed to the objective and supplied with openings of different sizes, either one of which may be brought before the lens by turning the plate.

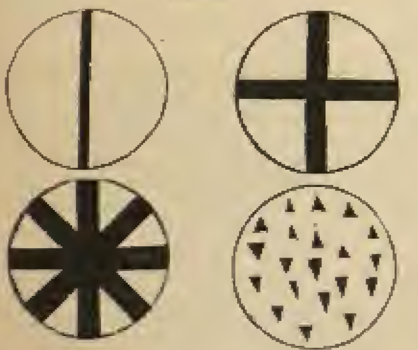
Rottenstone. A soft stone principally procured from Derbyshire, in England. The finest quality is used in the daguerrotype process for cleaning the plate. (See *Cleaning the Plate.*)

Rouge. Under this name the sesquioxide of iron is sold for polishing purposes to the daguerrean artist. It is prepared by precipitation and calcination. The best jewellers' rouge is prepared by calcining the precipitated oxide until it becomes scarlet. The sesquioxide of iron, prepared by precipitation, is an impalpable powder, of a brownish

red color. Rouge for daguerrotype purposes should be tasteless, and without a sense of grit when rubbed between the fingers or on the tongue. It is generally used separately, but a slight mixture of plumbago improves it. (See *Polishing the Plate.*)

Roundness of Figure. Disks of tinfoil or ferrotype plate may be cut similar to the designs seen in Fig. 176, and placed at the

FIG. 176.



back of the lens; and though largely increasing the exposure, the use of such has been found in portraiture to secure a much rounder figure. This is easy to understand.

Ruby Light. For the manipulation of orthochromatic plates only light transmitted through ruby glass or other medium can be used with safety. When ruby glass is not obtainable the following emulsion poured on glass will serve this purpose:

A. Gelatine	100 grains.
Water	4 ounces.
Potassium Bichromate	20 grains.
B. Silver Nitrate	20 grains.
Water	1 ounce.

Soften the gelatine in the usual way; add the bichromate and heat until all is dissolved, then add solution B. Coat the glass with this emulsion and a deep ruby color will result.

Ruled Screens. Glass screens with alternating black and white lines, generally called half-tone screens, are employed in the half-tone engraving processes by interposition between the object and the sensitive plate to break up and render possible the reproduction of the gradations of light, half-light, and shadow found in all other than line pictures. The preparation of such screens, either by ruling the glass with a diamond or ruling machine and filling in these lines with black pigment, or by copying original ruled screens by the wet-collodion process, is a work of great difficulty. Perfect ruled screens may be obtained commercially at a moderate price, and the practical worker will do well to avail himself of these rather than to attempt the manufacture of screens for his own use.

Russel's Dry Process. Major Russel, of England, was the first to apply tannin as a preservative agent for dry plates, and hence the name of this process, the manipulations of which are as follows: The glass plate is cleaned, collodionized, and excited in the usual way; the free nitrate is removed by an unlimited and thorough washing; and lastly the solution of tannin is poured over the plate and it is set up to drain, and finally dried by artificial heat. This is simple enough. The solution of tannin is made by dissolving 15 grains in an ounce of distilled water and filtering. It is always best to use a fresh solution and to pour it off the plate into the sink, and not into the bottle. The object of drying by artificial heat is to give greater sharpness and delicacy to the details. This may be done in a very simple way, by first heating a common flat-iron and then putting it on a levelling-stand in the centre of a pine box, against the sides of which the plates are arranged in a standing position. Be careful no white light finds its way into the box. The exposure is about the same as for other dry plates—about three minutes in a good light. The picture is developed with a mixture of pyrogallic acid and citro-nitrate of silver. You first moisten your plate with distilled water, and then pour the developer over it in the usual way. The picture comes out nearly as quickly as one upon ordinary wet collodion. When the blacks are sufficiently dense it can be fixed with a saturated solution of hyposulphite of soda and washed in the usual thorough way. The film in this process is peculiarly tender and liable to be torn in washing the plate after the fixing. The collodion should, therefore, be of the most adhesive and soapy kind, made with rather weak acids at a high temperature, and with excess of ether in the solvents, and as much pyroxylin as can be properly dissolved so as to give a good body and creamy film. As a further precaution, it may be

well to apply, with a brush, a narrow edging of spirit varnish all around the dry film; and if, in large plates, this precaution should not be found sufficient, recourse must be had to coating the plate with gelatine before applying the collodion. In using gelatine, let it dry spontaneously, or ridges may be formed, giving transparent lines in the negative.

S.

Sabatier's Amphi-Positive Process. The peculiarity of this process consists in the pictures being the result of a superposition, or entangling of two images, one negative, the other positive. It is based upon a capital fact, namely: that many substances poured in solution upon a negative *in course of formation* exercise upon it, whatever be the developing agent otherwise employed, a *disturbing* and *substituting* action, so that the development of the negative is stopped at the moment of contact, and the chemical combination that follows this contact gives rise to a positive. The substances which exercise this perturbating and substituting power are probably numerous. Perhaps they comprehend many neutral salts and all the alkalies, but it will be found that lime-water, solution of ammonia, and nitrate of silver possess this power in the highest degree. To establish the truth of a fact of so great importance, the following is the method pursued: Upon a sheet of white paper draw in strong black ink a series of large radii, then place it on a screen and focus it in the camera, expose on a collodion plate coated and sensitized in the usual way. Upon returning to the dark-room after exposure in the camera; pour on the collodionized plate an acidulated solution of pyrogallic acid, and when the whites of the paper begin to appear and long before the action of the developing agent is exhausted, wash the plate in distilled water, and pour on it a weak solution of nitrate of silver. One or two minutes after this last operation the whites of the image will appear unchanged, but the blacks will appear so much more intense in proportion to the diminished length of time the pyrogallic acid remained on the plate. The same result is arrived at if, instead of the nitrate of silver, we pour on the plate a solution of ammonia or a very weak solution of lime-water. This experiment infallibly succeeds provided the sensitizing solution and the weak nitrate of silver solution are perfectly neutral; it succeeds also when gallic acid or protosulphate of iron (containing no free sulphuric acid) is used as the developing agent, which places beyond the reach of doubt the perturbating and substituting influence of the three tried substances, whatever the developing agent employed. It is easier to prove this fact than to explain it; but for the guidance of those cultivating the art of photography who may be tempted to offer an explanation, the following facts must be noted, the first two of which are, so to speak, only corollaries of the capital fact established.

1. On the irregularly blackened plate of a microscope, place a glass containing a fly, and on the mirror beneath the plate, place a piece of white paper, then take a latent photographic image of the fly. Next proceed in the dark-room according to the method prescribed above; a positive is developed, not only of the fly, but of the blackened plate also. But if, instead of the white paper which forms the background of the little picture, a black paper is substituted, although the time of exposure be prolonged and the light more vivid, neither a positive of the fly nor of the plate is obtained on developing. It must not be supposed that the light was interrupted upon substituting a black for a white background, for the plate and the fly were both distinctly seen on the focussing glass; although, on attempting to develop a positive in the dark-room the collodionized plate remained white in spite of every effort, while it became black when it was not submitted to the luminous exposure. If the positive be not formed, it is only in consequence of the negative itself not being formed.

2. As soon as the negative is entirely developed, a positive is no longer possible. Nitrate of silver, solution of ammonia, and lime-water are without any influence upon the negative arrived at the perfect state.

3. The positive is not at first developed in the whole thickness of the collodion film; it commences at the surface next the glass, for it can be seen on that side long before it is visible on the other, and the hyposulphite, by dissolving the unimpressed iodide, renders the image visible on both sides.

It results from the preceding that nitrate of silver can, with each of the developing

agents, determine two successive combinations of different colors—the one being upon the whites of the image, and producing a negative; the other being upon the blacks and producing a positive. That these two combinations depend upon each other to this point, that the second commences very exactly at the moment when the first is stopped; that the second acts upon all the space left intact by the first, and lastly, the second becomes impossible from the moment the first is completed. The more the whites are developed, the less blacks there will be, and *vice versa*. The difficulty and importance is to appreciate in what proportions the two colors must be employed, to seize the exact moment when the formation of the negative must be stopped, so that the light and shade may be blended in the most harmonious manner; certain details will be rendered only by making one color predominate at the expense of the other. This method demands not only the skill and dexterity of an experienced operator; it requires also the knowledge and taste of a true artist. Every object represented will require special study. This new process in no respect modifies the operations which precede the employment of the developing nitrate of silver, it only necessitates the stopping the negative at a given moment after the wished-for effect is obtained. To this end the developing solution is washed off with distilled water, and the film covered with a thin layer of nitrate of silver of the strength of 20 grains to the ounce. This must be done very rapidly, for the pyrogallic acid adherent to the negative continues the developing action, even under the stream of water. It has been shown that the contact of the nitrate is alone sufficient to decide the formation of the positive. Moreover, if care be not taken to pour upon the plate moistened with the nitrate of silver a small quantity of pyrogallic acid, for want of materials the positive will come out with difficulty and will be apparent only in the deepest blacks. When the nitrate remains upon the plate one or two minutes previous to this addition, the positive is produced instantaneously and the whites of the picture lose their brilliancy; but if the nitrate acts only temporarily, so to speak, and immediately gives place to the acid, the positive develops itself under the eye with the greatest precision. If solution of ammonia be employed, or very weak lime-water, care must be taken to wash the plate with distilled water after the contact of these two substances; then it can be covered again with a layer of pyrogallic acid to which a few drops of nitrate of silver are added. But we must never lose sight of the fact that success is impossible when the baths contain the least trace of nitric or sulphuric acid. We must therefore give preference to fused nitrate of silver and make the image appear by pyrogallic acid, which, even in this case, maintains its undoubted superiority. The direct positives obtained by this process are fixed like the ordinary positives with hyposulphite of soda, and, like them, they assume in toning the hue we desire to impart to them. This process is applicable to albumen as well as to collodion; it is also applicable to paper, should some experimenter impart to it some of the qualities peculiar to the substances poured on the glass plate.

Saccharin. The sweet principle of sugars and other substances.

Safe-Edge. A method more particularly practised in the carbon or pigment process. Four narrow strips of black paper or tinfoil are so placed on the negative as to leave an opening for the picture a little smaller than the pigment-paper. In this way a white edge is left around the picture which makes the handling of the paper in the baths safer.

Safe Light. Light which, from its non-actinic color, does not readily affect light-sensitive photographic preparations.

Salt. In chemistry a body composed of an acid and a base, which may be either a metallic oxide or an alkaloid, as in the nitrate of silver, composed of nitric acid and silver, the former being the solvent and the latter the base; the resultant crystallization is the salt of silver.

2. *Salt.* Chloride of sodium. The ordinary salt of commerce is impure chloride of sodium. (See *Chloride of Sodium*.)

Salt of Gold. (See *Hyposulphite of Gold*.)

Salting the Paper. The process by which photographic paper is imbued with chloride of ammonium, chloride of barium, or chloride of sodium, which, in connection with the nitrate of silver afterward spread upon the sheet, forms the sensitive surface of chloride of silver. (See *Printing*, INDEX, etc.)

Salted Paper is pure photographic paper which has been floated or immersed for one or two minutes in a salting bath. The fol-

lowing is given as one of the salting-baths most commonly used:

Ammonium Chloride	60 grains.
Gelatine	20 "
Water	20 ounces.

Paper coated with starch containing common salt, and which, before printing, is sensitized in a solution of silver nitrate.

Salt Prints. Used by pen-artists upon Saxe paper. Sensitize with *neutral* silver nitrate 10 grains to the ounce in the usual manner. Dip the print in solution of 10 ounces of water with 10 grains sodium chloride and instantly remove. Make hypo bath alkaline by ammonia, strength 1 to 32. Dry upon a plate of glass, gumming a safe-edge while damp. It will be smooth. Let the artist, with waterproof ink, complete the drawing. Bleach by bichloride of mercury. A yellow stain is often, indeed usually, left. Make 10 per cent. solution of dioxide of manganese and hydrochloric acid; immerse until clean. A very good bleach may be obtained by a medium strong solution of perchloride of iron.—*C. Ashleigh Snow.*

Salts. Name for a combination produced by the substitution of an electro-positive radical (metal) of equal value for the hydrogen in an acid.

Sandarac. Gum obtained from a tree growing in Barbary (*Thuja articulata*); medium sized, yellow tears, easily melted and soluble in alcohol. Used in the preparation of varnish.

Sand-Clock. A clock used to mark the time of exposition in the camera. It consists of a glass tube, about 12 inches long by 1 inch diameter, half filled with fine sand, having a diaphragm in the centre with a small hole through which the sand runs. This tube is attached to a board which revolves on a central pin; on the side is a graduated scale, divided into half-seconds; and the tube is provided with a movable index. This instrument is attached in a conspicuous place, to the wall. The glass tube being revolved, the index is set to the number of half-seconds required, and the sand running down the required time is correctly marked.

Sandell Plates. Gelatino-bromide of silver plates, coated with several superimposed layers of emulsion of different and increasing sensitiveness. The emulsion next to the glass is the least sensitive, the upper one the most so. These plates are said to give just as good results with a hundredfold over-exposure as when normally timed, and to be entirely free from halation.

Sang's Dry Process. This process consists simply in using a preservative of molasses, or golden syrup. The manipulations are the same as for other syrups.

Saponifying. Dissolving gums or resins in alkalies, for instance, ammonia, soda, etc. The results are resin soaps.

Sapphire. Pure crystallized alumina. It occurs in hexagonal crystals, and also in grains and masses. The name sapphire is usually restricted to the blue crystals. It is next in hardness to the diamond. The term as used by the French in their works on photography is undoubtedly applied to the pure alumina used in sizing, etc.

Satin, Printing on. (See *Silk*.)

Saturate. To impregnate or unite with until no more can be received. Thus an acid saturates an alkali, and an alkali saturates an acid, when the solvent can contain no more of the dissolving body.

Saturated. Supplied to fulness.

Saturated Solutions. Solutions, which, at a given temperature, contain as much of the dissolved substance as, under the given conditions, it is possible for them to contain.

Saturation. The union, combination, or impregnation of one body with another by natural attraction or affinity, till the receiving body can contain no more. The saturation of an acid by an alkali is one sort of affinity; the saturation of water by salt is another sort of affinity, called solution.

Schlippe's Salts. Sodium thioantimonate, $Na_3SCS_4 + 9H_2O$. Large, colorless crystals, soluble in water. For strengthening thin negatives, and re-intensifying faded ones that have been strengthened with bichloride of mercury.

Sciopticon. A magic lantern of an improved convenient form, for use with oil or the gases. The invention of L. J. Marcy.

Scratching-Needle. This instrument is for the production of artificial negatives by scratching-in lines with one or several needles. Prepare a thin negative collodion containing much iodine, which is as usual poured over a glass plate and prepared in a silver bath. After having taken out the plate, and cleansing the same on both sides with water, it is dried and laid on a black

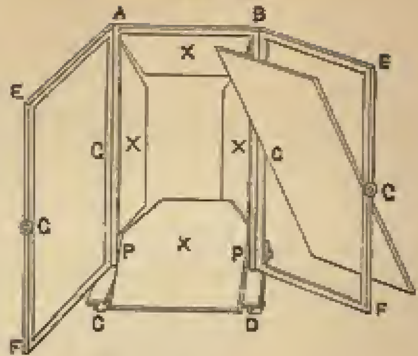
cloth, with the prepared side on top. If the collodion contained much iodine, the coating will appear of a light-yellow hue, which in this case is just the thing wanted. Now make several instruments, with two to eight needles ranged together in a straight line, with sealing-wax, with which a drawing can be scratched in the yellow layer of iodine silver. The diagram herewith represents the instrument, *a* being the sealing-wax, and *b* the points of the needles. After tracing carefully the outlines of a drawing upon the yellow layer, so that the layer does not get injured, proceed to the production of the whole drawing. For delicate details only an instrument of two to three needles is used; but large spaces are rapidly covered with an instrument of many needles. Each scratch appears black, as the yellow layer is removed, showing the black sub-layer. The picture is extremely pleasing, as the lines run beautifully parallel, and afford many delicate gradations. The scratched-off yellow dust must be often removed with a broad Martin brush. When the drawing is finished, pour on the plate a concentrated solution of fuchsin in alcohol, and wash off in water.

Fig. 177.

The fuchsin colors only the porous collodion, but not the clean spots of the glass, and renders the picture more opaque, so that it is perfectly suitable for heliographic or photo-lithographic purposes. Finally the negative must be varnished, but a diluted solution of gelatine or gum-arabic answers better, because an alcohol varnish dissolves the fuchsine.

Screen. An apparatus used in the studio for directing or reflecting the light to or from the model. Fig. 178 shows the adjustable screen, almost any effect being rendered possible by its use; A, B, and C represent a light frame of wood about six feet high and three and a half feet wide. E F, E F are two door-wings turning on pivots at G G, G G, consequently giving a universal movement. X X, X X are four inner wings on hinges at the frame, whereby one may enlarge or decrease the size of the opening, the lower wing moving in two pivots at P P. All this is lined on the back with strong paper and black muslin and on the front with pure white paper.

Fig. 178.



Screens, Color. Screens of colored glass or liquid screens formed by inclosing a colored solution between two glasses, or colored films, are used in orthochromatic photography to diminish the forces of certain light rays and gain true color-values in the negative. These screens are generally placed behind the lens, but if colored films are used they may be inserted in the diaphragm with good effect. Many formulas are given for the preparation of these screens; the following will prove useful for general work.

2. *Liquid Color Screens.* For light yellow screen, 1 per cent. solution of neutral potassium chromate.

For deep yellow screen, 5 per cent. solution of neutral potassium chromate.

For orange screen, 8 per cent. solution of potassium bichromate.

For red screen, 0.2 per cent. solution of erythrosin.

Gelatine films, obtained upon waxed and collodionized plates, stained with aurantia and afterward stripped from their supports, may also be used. As a rule, the color screens obtainable commercially are reliable and more economical than the home-made screens.

Screens, Fluorescent. Used in orthochromatic photography to intercept the ultra-violet rays of light. May be made by coating glass plates with: Æsculin, 1 part; water, 500 parts; glycerol, 40 parts; gelatine, 40 parts.

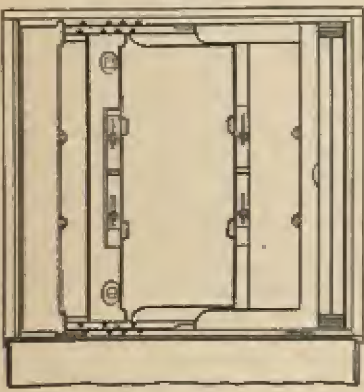
Screen Pates. (See *Ruled Screens.*)

Screen Plate Holder for Photo-Engravers. An arrangement for adjusting the position

of the screen-plate in making wet collodion negatives for photo-engraving work. Its principal points of superiority are thus briefly enumerated by the Scovill & Adams Co., New York, manufacturers:

First, the ease with which it is adjusted for different size plates and screens, by a simple sliding movement of the two inside frames to or from the centre, and thus dispensing with the expensive and troublesome use of kit frames. Second, the convenience

FIG. 179.



by which the screen plate is accurately adjusted to the sensitized plate by means of the metallic sliding adjusters, instead of adjusting by means of inserting different thicknesses of cardboard, paper, etc. Third, different thicknesses in the screen-plate are allowed for by means of a spring which always holds the plate in accurate place, no matter what its thickness may be. Fourth, a graduated scale on each screen-adjuster makes it easy to always insure absolute accuracy in determining the distance of the screen-plate from the wet plate.

Sealing-Paper. An adhesive paper used for the double purpose of cementing the daguerrotype, ambrotype, lantern slides, etc., and the diaphragm, or matt, and glass which covers them together, and to protect the picture from the action of the atmosphere. There are many ways of making sealing-paper; the following will be found as good as any: In 3 parts of water dissolve ½ ounce isinglass; ½ ounce gum tragacanth, and 2 ounces gum-arabic over a gentle flame. Boil it down to the required consistency, and apply it to any paper not *too* thick. A little gum benzoin or sugar may be added, as they are thought by some to improve the mixture.

Seascape Photography may be naturally divided into two sections: work done from the shore and work done upon the sea, from ships, etc. For the first and second alike considerable expertness is required to avoid the moving of the camera during exposure, to obtain a rigid support during exposure, and in the exposure itself. Over-exposure is a common fault in this work. When photographing from a vessel a clamp will secure the camera to some convenient support, and give better results than the tripod. A good view-finder and camera level are indispensable to success. The lens should be fitted with a quick, easy-working shutter; and for views combining only sea and sky the use of a smoked glass or color-screen behind the lens is advised.

Sector Shutter. An instantaneous shutter with sector-formed shutter plates. It opens from the middle, but allows, even at the beginning of the opening, of the action of the edges of the objective. It is a centre shutter (between the lenses).

Selenium. A red amorphous precipitate from selenic acid. Only the coarse-grained, crystalline modification, of metallic lustre, is of importance in photography. This will conduct a galvanic current about ten times as well in the light as in the dark, opposing a variable resistance to it in variable illumination. On this account it has been utilized in the construction of the photophone and several other photo-telegraphic instruments.

Self-Developing Negative Process. This process is upon paper. To obtain good results the paper must be moderately thin, of very fine texture, and made of one description of fibre—one which freely takes wax and is easily rendered transparent. Select the paper with these requirements and remove *all* the sizing in water acidulated with nitric acid and subsequent washing in distilled water. Lay the wet sheets on a table covered with a clean cloth free from starch, and allow them thus to dry. The paper should be perfectly bibulous after this treatment. The dry paper is placed on the surface of a bath of iodide of iron containing about 10 grains of iodide in 1 ounce of water. It is allowed to repose on this one minute, when it is removed by wooden forceps and laid,

wet side downward, on a sheet of clean glass and left to dry. This part of the process may be performed many hours before the paper is made sensitive. When required for the camera it is placed upon a bath of nitrate of silver containing 50 grains of the salt to 1 ounce of water. If the paper be required to keep good for an hour or two it must be left on this bath for five minutes; if to be used immediately one minute will be sufficient. The degree of sensitiveness, or rather rapidity of development, will be found to depend, in inverse proportion, upon the duration of exposure to the silver bath. On removal from the bath the paper is placed, prepared side downward, upon the glass of the slide, so that when exposed it is behind the glass. Slips of thick cardboard placed under the glass will prevent the paper coming in contact with the wooden partition of the slide. If the paper has been one minute on the silver bath the exposure in the camera should be for about three minutes. If it has been five minutes in the silver solution the exposure should be from five to ten minutes. No developing agent is required. The picture is developed quickly or slowly, according to the time the paper has been on the silver bath. It may be out perfectly in ten minutes or it may take an hour; the lights will not spoil until the picture is completely developed. The dark parts are of intense blackness and of the most complete opacity, and the picture is completely in the substance of the paper. The proof should then be washed well in distilled water, or in common water slightly acidulated with sulphuric acid, and subsequently fixed in hyposulphite of soda solution. The object in acidulating the water is to prevent the formation of a deposit of oxide of iron which otherwise would make its appearance and soil the picture.

Sensitive. A term applied to the compound, whether for the daguerrotype plate, or paper, or glass processes, used to give sensitiveness to the surface of the tablet upon which the image it to be impressed by light.

Sensitiveness. The property of certain salts (generally iodide, chloride, and bromide of silver) to become changed, chemically, by the action of light and becoming black in subsequent development. The degree of sensitiveness indicates how quickly this blackening will take place. This degree in the modern bromide of silver plates, films, and papers, is usually ascertained by a sensitometer. Ten degrees Warnerke sensitometer (or "10° W.") correspond to 1 degree of a wet collodion plate; the highest number is 25 degrees W., for instantaneous plates, which is about fifty-three times greater sensitiveness than that of a wet collodion plate.

2. *Sensitiveness.* The facility of receiving impressions from very feeble rays of light, or of receiving quickly from brighter rays. Sensitiveness is dependent upon the purity of the chemicals used and the method of using them. A certain portion of nitrate of silver in the iodized film renders it quite sensitive to light, but any further addition has no further accelerating effect, while a reduction of that proportion sensibly decreases the action. Free acids in the bath, additions of certain organic matters, like albumen, gelatine, glycyrrhizin, etc., impurities in the iodides, the presence of free iodine, or of bromides and chlorides, a too dense film, or a want of a due proportion of iodine in the film, impurities in the alcohol and ether, decomposition of the collodion or of the nitrate bath, are some of the conditions which influence a *decrease* in the sensitiveness of the photographic film; while the conditions which *increase* its sensitiveness to light are perfect neutrality of the reactions employed; a soft gelatinous state of the film, absence of salts which precipitate nitrate of silver; an undecomposed collodion, containing no organic matter of that kind which is precipitated by basic acetate of lead and combines with oxide of silver.—*H. H. Snelling.*

Sensitive Film. The film or coating covering the surface of paper, daguerrotype plate, plate of glass, or other substance rendered sensitive to the action of light.

Sensitive Paper. Paper prepared with the sensitive solutions to receive the image of the object to be impressed by light. (See *Photographic Printing*, *Printing*, *Negative Paper*, *Paper Negatives*, etc.)

Sensitive Solutions. Those photographic solutions by which the various photographic surfaces are rendered sensible to the action of light, and by the reduction of which the photographic image is produced.

Sensitive Surfaces. Surfaces, whether of glass, paper, wood, or other substance, that are rendered sensitive to light for the production of the photographic image.

Sensitize. To sensitize is to render a solution or surface sensible to the action of light.

Sensitized. Any substance imbued with a sensitive agent is said to be sensitized.

Sensitizing. The act of rendering a solution or surface sensitive to the action of light. To make light-sensitive by dipping into nitrate of silver solution, etc.

Sensitizing Bath. The solution in which the albumen, collodion or other plate or paper is rendered sensitive to the action of light. (See *Nitrate Bath*, *Negative Process*, etc.)

Sensitizing the Paper. The art of applying the sensitive solution to paper. (See *Printing.*)

Sensito-Colorimeter. An instrument invented by Leon Vidal for determining the normal sensitiveness of orthochromatic plates for the different colors. It resembles the sensitometer of Warnerke, but differs from it in presenting, instead of a scale of numbers, one which shows in twenty-one squares the seven foundation colors of the spectrum in three different degrees of density. An orthochromatic plate normally exposed under such a scale indicates to what colors it is sensitive.

Sensitometer. Dr. H. W. Vogel describes the following form of sensitometers for testing plates. He says: "In order to clearly indicate how far the effect of light has progressed, a thin strip of tin is fixed under the cells, in which figures are cut to indicate the number of holes made above.

FIG. 180.

For exposing, use a sheet of white photographic paper, which is drawn upon a board, B, which board is exactly one metre distant from the photometer (see Fig. 180), which is lighted by a small window, about twenty feet distant, facing directly to the sky, through an aperture in the studio protected with screens. As the strength of the daylight is very variable, even during the time of exposing the two plates, I use a double instrument, as shown in the annexed diagram, and in which the two plates can be exposed simultaneously (Fig. 181). Of course the plates are also developed simultaneously and equally long. The temperature of the developer is of special importance. With a warm developer often three or four figures more are reached than with a cold

FIG. 181.

one, and it is therefore necessary to keep the developer as nearly as possible at the same temperature (66° Fahr.), which can be done by using ice in summer and warm water in winter. Of course, this must be done only when it is intended to compare the results of experiments made in winter. If the two plates are exposed simultaneously, and also developed at the same time with the developer the temperature does not modify the results."

A sensitometer devised by L. Warnerke is also used. It resembles a printing-frame. In it a glass plate is placed, divided into twenty-five equal squares, printed in gelatine color of varying consistence or thickness, so as to make the first square the most, the twenty-fifth the least, transparent. These squares are numbered from 1 to 25 in fatty, non-transparent ink. Before the frame a glass plate is fixed, painted with luminous paint; the dry-plate to be tested is placed in the frame, film toward the numbered squares. An inch of magnesium wire is burned before the plate painted with luminous color, and after a minute the dry-plate within the frame is exposed to the now self-illuminating painted glass plate. After development the intensity of the reproduced figures represent the sensitiveness of the film.

Sepia Tones on plain salted paper may be obtained by using an ordinary gold bath of one-half the usual strength; for this purpose the prints should not be printed too darkly,

For sepia tones on bromide paper the prints are developed as usual with ferrous oxalate and washed, then immersed in the following:

Ferrocyanide of Potassium . . .	9 grains.
Uranium Nitrate	8 "
Glacial Acetic Acid	5 drachms.
Water	16 ounces.

Success depends chiefly upon thoroughly washing all iron and hypo from the prints before toning.

Serre's Negative Process. This process is due to M. Victor Serre, who gives the following method of manipulation: "Use paper strongly sized with gelatine, or albumenize on both sides with a mixture of equal parts of albumen and water. When the paper is dry I coagulate with a hot iron. For the preparation of a sensitive surface, I use albumen iodized with iodide of ammonium, to which is added a little gum, sugar candy, and sugar of milk. I sensitize on a solution of aceto-nitrate of silver of a strength of 5 per cent.; when I wish to prepare several sheets I take a plate of glass, rather larger than the sheet of paper, and by means of a glass funnel pour upon it a quantity of the aceto-nitrate sufficient to sensitize the paper, which I immediately place upon it; the sensitizing completed, I place the sheet in a dish full of ordinary water, repeating the operation with every sheet of paper. When they are all collected I throw away the water; renew it until what remains is perfectly clear—a certain sign of the complete precipitation of the nitrate of silver. I then place in the dish full of water a small quantity of liquor ammoniæ, to dissolve the chloride of silver, and agitate strongly for five or six minutes. The paper is next removed from the dish and dried between blotting-paper, enclosed in a cover of clean paper, and well pressed. To calculate the time of exposure, a trial must be made at home with the paper wet—the dry paper will not undergo a longer exposure—taking into account the light, diaphragm, and foliage. When returned to the laboratory, a film of aceto-nitrate solution (3 or 4 parts to 100) must be poured upon the glass plate, and the impressed side of the sheet of paper carefully deposited upon it; after a few minutes the paper is to be plunged into a bath of saturated solution of gallic acid to which camphor has been added. The image will soon appear, with the half-prints perfect and the blacks strong.

Serum (Whey, Posset). The aqueous liquid which remains after the butter and casein have been removed from the milk. Used sometimes on plain paper to impart brilliancy to the prints without too much gloss. As a photographic agent it is used in the following manner:

Preparation of Negative Paper. Into half a pint of serum of milk, which is strained through fine linen to separate the *casein*, stir the white of an egg; after depriving it of all solid matter, boil it; then strain it again through a paper filter, after which, upon cooling, dissolve in it 3 per cent. of its weight of iodide of potassium. To use this liquid proceed in the following manner: Plunge the paper which is to undergo the preparation into the liquid, in which let it remain for two minutes, and when it is very uniformly impregnated, dry it by suspending with two pins to a piece of tape which is placed horizontally. This preparation is conducted in daylight, without any particular precaution; the paper can be used in the most flexible state. We then dry it with the blotting-paper before submitting it to the aceto-nitrate. If it is intended for subsequent operations, it should be left to dry completely. Protected from moisture and dust, this paper keeps almost indefinitely. Papers with the serum have not the sensitiveness of those prepared with the saturated solution of iodide of potassium; they are therefore less practicable for the execution of portraits. We renounce them in the execution of objects which require a short exposure, and adopt them exclusively in the reproduction of those in which the duration of exposure is not important (and for a long exposure it is necessary to make a difference of one or two minutes), and it is preferable, therefore, to choose them rather thin, as the images have more power of depth in the body of the paper, and consequently, more gradations in the general effect of the picture. When we work with a paper but slightly sensitive to light, the strongly clear parts are the only ones which are impressed during the first periods of exposure; the demi-tints are scarcely represented in comparison with these, and the lights and shades have an extreme dulness. With the very sensitive preparations, a nearly contrary effect is produced: the clear parts are copied without clearness; all the details are blended—without design and without har-

mony. We then say that the proof is overdone. The parts which are in the shade, or the deep dark, on the contrary, reflect less light. The photographic action is less active —sufficiently energetic to form a well-delineated image. This action has not intensity enough to compromise the purity of the lines and the clearness of the details. The very sensitive preparations do not bear the effects of light, unless a certain arrangement of the picture peculiarly counteracts the difficulty, for in wishing to push the exposure too far we carry off the image under the glare of light, and all detail disappears.

Preparation of Dry Paper with Serum. To use serum in the dry state, it must, after being submitted to the aceto-nitrate, be dried between two sheets of blotting-paper, and another sheet of lining paper laid outside, which should be perfectly dry, and then placed between two glasses in the holder of the camera. The sheet thus pressed between two glasses insures a very even surface, and preserves its photographic qualities several days. But in summer the paper should be extremely thick to remain good twenty-four hours. Very fine paper would perhaps not keep an hour at this high temperature, while it is easily preserved a day or two at zero. It is therefore important to avoid passing the paper to the aceto-nitrate except at the moment of using. The dry paper is less sensitive than the wet, and it is necessary to expose it three times as long in the camera. Dry papers must be rejected when we wish to obtain proofs promptly. For inanimate objects in which the time of exposure may be prolonged with impunity, dry papers are more suitable, and when they are very thick the proofs are finer and more delicate, and the gradations of light more perfect. (See *Solar Printing by Development.*)

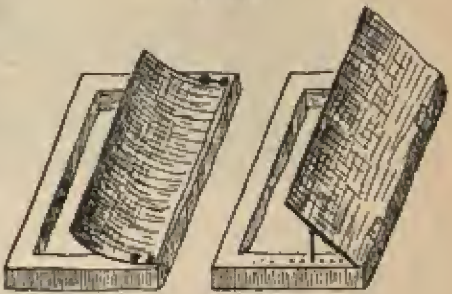
Serum Dry Process. Take any collodion suitable for a dry process; coat the plate, sensitize and wash in the usual way; then immerse it in a dish containing sufficient serum to cover it for three minutes. After draining the plate the back is sponged and wiped clean, and placed in the drying-box.

Shadbolt's Dry Process. This is a dry process in which the syrup of honey is used as the preservative agent. The first employment of honey for this purpose is due to Mr. Shadbolt. (See *Honey Process.*)

Shade. That portion of the picture developed by the action of the light upon the sensitive coating and which gives prominence and action to the image. The shades of a picture should be transparent, soft, harmonious and well blended with the light portions; except in the extreme outline no harsh or abrupt terminations of the shades should be perceptible, no matter what their tone or color may be.

Shade for Printing-Frame. Used to secure uniformity in printing the sky or extreme distances without losing detail of any part. The shade may be made of a piece of

FIG. 182.



thin zinc, curled as much as is necessary to meet the wants of the moment, and is held in position by four large-headed drying-pins. The zinc should be cut with exactness, so as to slip into the groove formed by the heads of the pins. The printing-frame should be larger than the negative.

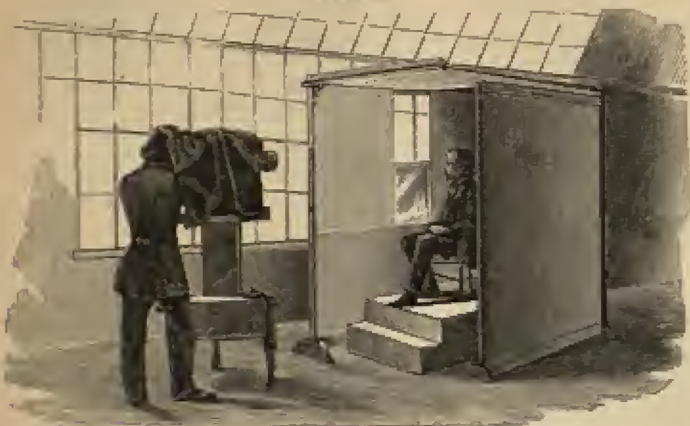
Shadow Chamber. Sometimes when a skylight is found uncontrollable, use has been made of a sub-studio, so to speak, constructed inside the larger one. Such a help, called a "shadow-chamber," suggested by E. J. Foss, is contrived as illustrated on next page (Fig. 183).

It is a conglomeration of sliding curtains which can be moved quickly, securing an endless number of effects.

Mr. Foss's studio has a side-light, thirteen feet wide and ten high, connecting with the skylight, which is thirteen feet square; the glass is all ground; the angle of the skylight is thirty-five degrees; there is a space from side- and skylight to the back wall of nine feet; in the ceiling of this space is a window some three feet wide, which extends clear across the room; this light is used for the purpose of lighting up the backgrounds, of

which there are several, on rollers, fastened to the ceiling; the three-feet light does not reach the sitters, they being in the "shadow chamber."

FIG. 183.



Sharp. A term applied to a photograph well defined in every particular; bold in its outline and well filled out in detail. It is also applied to the camera when these effects are produced by that instrument.

Sharpness. The perfect definition of the photographic image, either negative or positive. Many photographers misapply this term to hard, abrupt outline and detail. True sharpness in a photographic picture produces *roundness* in all its parts without *harshness* of outline, which, although it gives prominence to the outline as if the positive were cut out and pasted upon the surface, renders the detail flat, inharmonious and devoid of gradation of light and shade. The relative value of the two terms may be illustrated by viewing through a stereoscope two stereographs, one perfect in all its parts, the other under-printed, overtoned, and cut to the outlines and pasted in that manner upon the cardboard.

Sheaths. Black tin frames, open in front, into which hand-camera plates are placed to protect them when being changed, and to prevent the light striking the plate next behind.

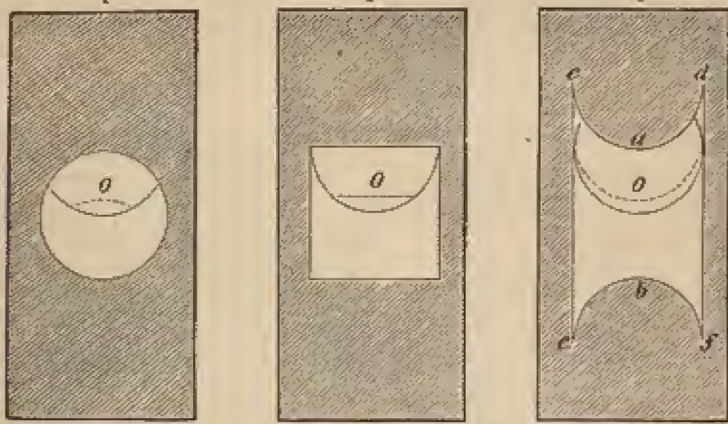
Shellac. Dark-red gum, soluble in alcohol. Used for varnish.

Shutters for Instantaneous Work. Mr. Quidde gives the following information: Fig. 184, 1 shows a shutter with a circular aperture of the size of the objective. 2, Fig. 184, shows a shutter with a square aperture, the depth of which corresponds with the diameter of the objective; and 3, Fig. 184, shows a shutter, the aperture of which is wider on the margins than in the centre. The distance from *a* to *b* is equal to the objective diameter, and the radius of the circular arc *c a d* and *e b f* equal to that of the objective aperture. If the three boards are moved with the same degree of rapidity, the time of exposure in regard to the vertical diameter of the objective will be identical for all three boards, for all three have to move the same distance, but the effect of the light differs very much with all three: a moment occurs in which the whole objective is free, the effect of light being in consequence the same with one as with the others; but this is only for a moment—in every other position a very material diversity is manifested, which becomes more marked at the beginning or conclusion of the exposure. In the above diagram the moment is represented when the top edge of the aperture has arrived in the centre of the objective opening. In 1, Fig. 184, we see less than half of the objective aperture *o*; in 2 we see exactly the half, and in 3 more than half of the objective aperture. The difference is shown in a still more striking manner just before the conclusion of the exposure, as indicated by the dotted lines. One can easily calculate in this manner that the effect of light of the three shutters in 1, 2 and 3, with equal movements, and all other circumstances identical, stand in the same relation as the superficial contents of the respective apertures, which is approximately expressed by the relation of the numbers 11, 14 and 17 to each other. The latter form of shutter is, therefore, the most advantageous, for it exposes the margins of the picture, which have relatively less strength of light, longer than

the centre. But many other forms are in market, some of which expose the margins of the picture too short a time. (See *Norton's Cloud-Catcher.*)

the wall, or by means of the instrument called a pantagraph. The term is also now applied to photographs taken for the purpose of reproductions in statuary.

Fig. 184.



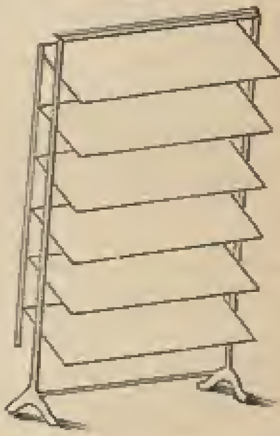
Shutters, Exposure. The introduction of very rapid plates has necessitated the devising of means by which the exposure may be controlled with certainty, whether it be the fractional part of a second or a much longer period of time. This is secured by shutters of various forms, which may be seen by reference to the catalogues of dealers in photographic supplies. Shutters are divided into two classes: those intended for very short exposures, called *instantaneous shutters*, and those for longer exposures, called *time shutters*. Several forms admit of both instantaneous and time exposures.

Side Screen. A simple arrangement of frame and adjustable blinds for use in a studio. When the blinds are closed it can be used as a solid screen or reflector. (See Fig. 185.)

Silhouette. A term applied to the representation of an object filled in, of a black color, and in which the inner parts are sometimes indicated by lines of a lighter color, and shadows of extreme depths by the aid of a heightening of gum or other shining medium. This kind of drawing derives its name from its inventor Etienne de Silhouette. Representations of this kind may be well enough taken from the shadow of a person thrown on a piece of paper placed against

Silhouette Photograph. Two black backgrounds, made of cloth or of velvet, one white background, and a piece of black cloth,

Fig. 185.



are all that is required for making silhouettography by the Stumman process. Arrange in the glass-room the two black backgrounds so as to form a sash passage

two yards wide, parallel to the sash, and distant from this about one yard. Cover the two black backgrounds with a piece of black cloth, to form a roof. You have in this manner a small tunnel, one of whose outlets is turned toward the camera; at the distance of a yard from the other outlet place a very white background, and light it well. The person of whom it is desired to make a silhouette portrait is placed in this little improvised tunnel, so that the profile is cast sharply on the white ground. The part of the face turned toward the objective being but very little lighted, we see on the ground-glass of the camera only a silhouette on a white ground. The time of exposure should be rather short. The plate is develeped in the ordinary manner, but the development is pushed a little in order to get a very white background.

FIG. 186.

Silicates. Salts found in Nature as monosilicates, disilicates, and trisilicates. Used in the manufacture of glass and porcelain and in ceramics. Barium silicate glass is used in the Zeiss anastigmats (q. v.) on account of its clearness and non-obstruction of the chemically active rays.

Silicate of Potassium. Syrup-like solution of alkaline reaction, drying in the air to a glass-like mass. Used very dilute in cleaning plates.

Silk, Printing on. Prints upon silk, satin, cotton, or wool fabrics may be obtained as follows: To prepare the silk for printing immerse for a few moments in a solution composed as follows:

Alcohol	1000 parts.
Benzoin	8 "
Mastic (in tears)	5 "
Chloride of Cadmium	30 "

Allow the silk to dry, then sensitize in the following solution:

Nitrate of Silver	120 parts.
Water (filtered)	1000 "

Dry and iron the silk; print as is usual with albumen paper, but with care, watching the progress of printing, so that in lifting the silk from the negative blurred lines do not result.

When sufficiently printed wash well in five changes of water, and tone in any toning-bath, which, however, must be diluted by the addition of water equal in quantity to the volume of the bath used. M. Schaeffner recommends the subjoined toning-bath as especially adapted to this process:

Pure Water	1000 parts.
Chloride of Gold	0.25 "
Bicarbonate of Sodium	2.50 "

This bath should be prepared several hours before use. The silk prints should be kept moving while toning. When toned immerse for a moment in a bath of clear water, and fix in

Water	1000 parts.
Hyposulphite of Soda	100 "

for ten minutes. Wash afterward for a few hours in running water, dry in the air, and afterward with an iron press the silk prints while they are slightly damp.

To finish these prints in monochrome or colors, dilute the color used with a solution of 1 part of alum in 10 parts of water.

Here is a formula for sensitizing cotton, silk, or wool fabrics, or canvas for painting, so that prints may be made from photographic negatives upon them as a guide for decorative work:

Ammonium Chloride	2 parts.
Water	250 "
Whites of Two Eggs.	

When dry, sensitize by floating upon a 60- to 70-grain nitrate of silver bath. Tone, fix, etc., as usual.

Silver. Ag. Comes in larger or smaller pieces, and in combinations of various kinds. For photography, only its salts are of importance.

Silver Albuminate. Albuminate of silver. A probably indefinable combination, which is formed when albumen in solution is precipitated by a silver solution. It is white and insoluble, and transformed by sunlight into a red mass (albuminate of silver suboxide).

Silver Bath. Aqueous solution of nitrate of silver of varying concentration. Used for sensitizing albumen or salted paper and wet collodion plates.

Silver Ink. Triturate in a mortar equal parts of silver foil and sulphate of potassa until reduced to a fine powder; then wash out the salt and mix the residue with a mucilage of equal parts of gum-arabic and water.

Silvering. Coating the daguerrotype plate with a thin film of silver. (See *Galvanizing the Plate.*)

Silvering Liquid. A solution of oxide of silver and cyanide of potassium in water, into which the daguerrotype plate is plunged during the silvering process.

Silvering the Plate. (See *Silvering.*)

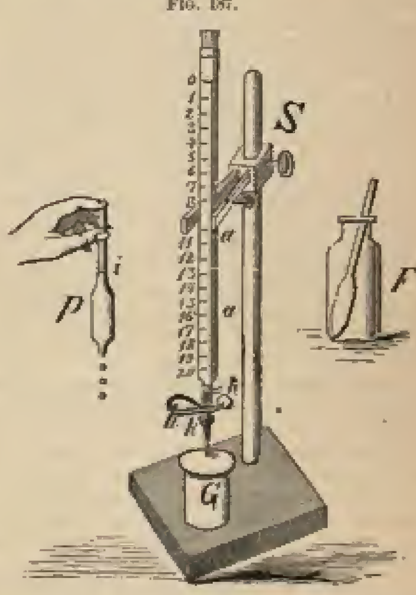
Silver-Meter. Obtain a light glass flask, tube, or other convenient vessel of *little more than one ounce capacity when quite full;* into this measure one ounce of distilled water, then fit a cork with one of the fine glass tubes pencil leads are kept in through the centre (or simply as a V groove), and adjust it to the neck until the water appears at the top of the tube. Mark its position on the neck at the bottom surface. Now weigh the whole arrangement in the balance and obtain the counterpoise in one piece for future use. By substituting the solution of silver under trial, for the water, you will ascertain the number of grains per ounce by the extra number of grains it takes to equipose the vessel.

Silver Printing. A printing process in which a film, made light-sensitive by silver salts, serves as carrier of the picture. (See *Printing.*)

Silver Stains from Negatives, To Remove. A solution of 1 part of iodide of potassium in 20 parts of water is recommended. The negative is laid in this solution until the stains disappear. The bath can be used repeatedly until it becomes milky. The negative is not injured in any way by the solution.

Silver Test. (Invention of Dr. H. W. Vogel.) It consists of a stand, *S*, a burette, *a*, two pipettes, *p* and *F*, and a beaker glass *G*. A solution of iodide of potassium is prepared containing $1023\frac{1}{10}$ cubic centimetres of water, exactly 10 grammes of pure iodide of potassium. In 100 cubic centimetres of this solution precipitate 1 gramme of nitrate of silver, so that if one cubic centimetre of a silver solution is measured off and tested every cubic centimetre of the test

FIG. 187.



solution used gives 1 per cent. of nitrate of silver (1000 cubic centimetres = 2.11 pints, and 1 gramme = 15.4 grains). This prepared solution is placed in the burette, *a*, which is divided off into cubic centimetres, and furnished with a pinch-cock, *k*. The pipette, *p*, is then dipped into the silver solution to be tested, filled, by drawing with the mouth at the upper end to the mark *i*, which is an exact cubic centimetre, and the solution allowed to run into the glass, *G*. Into the same glass, *G*, are placed one or two cubic centimetres of prepared nitric acid, using the pipette *F*. (This nitric acid con-

tains 1 grain of protosulphate of iron to every 2 ounces of pure acid). And finally 10 to 14 drops of a prepared starch solution are added. (This solution is made by rubbing up ¼ ounce of starch to a thin paste with distilled water, pouring it into 12½ ounces of boiling distilled water, and stirring for several minutes; after setting for a few hours the clear solution is poured off, and 2½ ounces of pure pulverized nitrate of potassa added, when it is ready for use, and will keep undecomposed for about six weeks). The solution in the burette, *a*, is then allowed, by pressing open the pinch-cock, to run into the glass, *G*, until the blue color which is produced does not disappear by shaking, but remains permanent. With a little care at the close of the stirring a single drop will be found sufficient to produce this permanent color. A simple reading of the number of cubic centimetres of solution used gives the per cent. of nitrate of silver. Thus, if it stands at 7½ per cent., that is, 100 cubic centimetres of solution contain 7½ grammes nitrate of silver, it is equivalent to about 35 grains to the ounce.

Simile Platino-Paper. A paper prepared with a mixture of soda, ferric oxalate, and oxalate of silver, which, when developed with hot water or steam, furnishes prints resembling platinum pictures.

Simple Collodion. Collodion without any admixture of the sensitizing agents. (See *Collodion*.)

Single Achromatic Lens. The simplest and cheapest form of photographic objective, in which color diffusion (difference of optical and chemical foci) has been avoided by the union of crown and flint glass. When insufficiently diaphragmed, the achromatic lens renders the straight lines at the edges curved. (See *Distortion* and *Aberration*.)

Single Lens. A photographic objective of but one combination, consisting of a crown glass condensing lens cemented to a flint glass diffusing lens.

Single Transfer Process. The method of transferring a carbon print from its paper support to another final support. Such pictures are reversed unless reversed negatives are used.

Sitter. The model, or subject; the person who is being photographed.

Size. Dimensions of plates and pictures. The size of plates in Germany are: 9 x 12 cm. (quarter plate); 13 x 18 cm. (half plate); 18 x 24 cm. (whole plate); 21 x 27 cm. (extra); for landscapes mostly 12 x 16 cm. The International Photographic Congress has proposed as normal sizes: 9 x 12, 12 x 18, 18 x 24, 24 x 36, 36 x 48.

Usual picture dimensions in millimetres in different countries: Mignon, 60 x 35; visite, 104 x 62; Victoria, 126 x 80; salon, 250 x 175; boudoir, 220 x 133; excelsior, 320 x 260; panel, 380 x 280; royal, 480 x 380; Nature, 580 x 480; cabinet (album), 165 x 110; promenade, 210 x 100.

Size of Drops. In technical formulæ proportions of fluids are sometimes given in *drops*. As the drops of different fluids vary considerably in size, it is desirable to be able to compare them with a standard measure. Dr. Eder gives the number of drops required to make a *cubic centimetre* as follows:

	Drops.
Water	20
Hydrochloric Acid	20
Nitric Acid	27
Sulphuric Acid	28
Acetic Acid	38
Castor Oil	44
Olive Oil	47
Oil of Turpentine	55
Alcohol	62
Ether	83

By remembering that 1 cubic centimetre is equal to 17 minims, the proportion of drops in any formula may be converted into English measure.

Sizing. A preparation of any mucilaginous substance in water spread on the surface of paper to render it less pervious to moisture, and to harden its texture. The photographic sizes are albumen, serum, gelatine, dextrin, starch, inulin, virgin wax, collodion, and various vegetable gums.

Sizing the Paper. Dissolve serum, gelatine, or other substance, in water to the required consistence, and pour it into a dish, placed horizontally, taking care that there is no froth. Take the paper and wet it on one side only, beginning at the edge of the dish which is nearest to you, and the longest side of the sheet, placing the right angle on the liquid and inclining it toward you, move it forward in such a manner as to exercise a strong pressure, which will remove the air-bubbles. Let the sheet imbibe two or three minutes without touching it; then take it up gently, but at once, with a very regular movement, and hang it up by the corners to dry. Prepare thus, in the same bath, as many sheets as desired, taking

care that there is always about a quarter of an inch in depth of solution in the dish. Then place all your dried sheets, one on the other, between two leaves of white paper, and pass over them several times a very hot iron, taking out a sheet each time; you will thus render the sizing insoluble. The iron should be as hot as possible without scorching the paper. (For other methods see *Collodion Process*, etc.) As a general principle, although a sizing may be perfect for photographic papers, it is necessary that it should be dissolved in the same liquid which contains the preliminary preparations, and that it afterward becomes, by drying, insoluble in other preparations to which it is to be submitted. Starch, inulin, glycyrrhizin (liquorice), gelatine, mucilage of linseed, sugar of milk, serum, animal and vegetable albumen dissolved in water, resins, camphor, fermented gluten and collodion dissolved in alcohol, possess the properties, and are therefore excellent.

Skaife's Method of Enlarging. The atmosphere of London being so often obscured that the solar camera is rendered of little use, Mr. Skaife devised the following process for operating with an ordinary flame, a gaslight, or an electric light. The negatives he uses are what he calls pistolgrams, a small picture of almost microscopic size. Now, supposing a large picture is to be reproduced, he places a lamp in the focus of a reflector, the flame of which is reflected upon the surface of the pistolgram, which is placed in the pistolgraph (a very small camera), which is posed opposite the reflector, at a distance from the latter of about double its radius, and the lamp midway, or nearly so, between the two, moving the lamp backward or forward until the pistolgram becomes brilliantly illuminated. Now, if a white screen be placed in front of the pistolgraph (from which the shutters have been removed) say at the distance of three feet, an enlarged image will appear projected thereon, *à la* magic-lantern. Beneath the screen upon which the magic photograph is projected he places a second table, *vis à vis* the first, upon which stands the pistolgraph, lamp, and reflector, a sufficient space being left between the two tables to admit of the operator and and his chair. Upon the second table he places a drawing-board, fixed perpendicularly in a foot, which when viewed in profile has the form of a ⊥ square. To the drawing-board he fixes a sheet of drawing or common cartridge paper, with a little paste, at the upper corners. This done he fixes upon the size of the print desired, by sliding the drawing-board nearer or farther off from the pistolgraph, and gets the proper focus that way, or by turning in or out the screw of the lens. He then takes a small sable pencil dipped in a little neutral water tint, and passes it over all the light parts of the picture, repeating the process until the illuminated parts have attained the shaded density of the shadows. Which done, on bringing a light to the front of the lens, an imitation photograph will be found to be the result; and although this imitation, if hastily done, will be found wanting in some of the minor details of the original, the deficiency will be found more than compensated by the better adaptation of the imitation than the genuine photograph to receive colors thereon when applied by the skilful touch of the accomplished artist.

Skylight. A window placed in the roof of a building for the admission of light. The skylight for the daguerrean room, no matter what may be its size or exposure, should be at an angle of about forty-five degrees. Some artists place it at forty. If possible it should look toward the northwest and should be protected against the full glare of the sun by screens of lattice-work or white cloth. There cannot be a doubt in the mind of anyone who has *studied* his art, that blue glass might be adopted for skylights with marked improvement of effect, and certainty of manipulation.—*H. H. Snelling*, 1870.

The proper light for a photographic gallery should neither be a *skylight* nor a *sidelight*, but both judiciously combined, so as to fall obliquely upon the subject. This can be effected by having the opening partly in the roof and partly in the side of the wall of the building, to within two feet of the floor of the room. Such an opening would afford abundance of light for a group of any number, and distribute the lights and shadows properly over the whole, the effect of which would be striking and rich. The light falling thus upon the eyes, does not destroy their beauty, but, on the contrary, gives a clear outline of the iris of the eye, and imparts a proper transparency and depth which cannot be obtained by an absolute sky-light, and so of all the other features. The three

feet space between the skylight and the floor may be filled with glass, provided with shutters, to be opened or closed as the exigencies of the case may require.

The view given is from the east side, thus showing the arrangement of the top and one side. Of course, then, the side we see is the west side; by the chair we observe where the

FIG. 188.

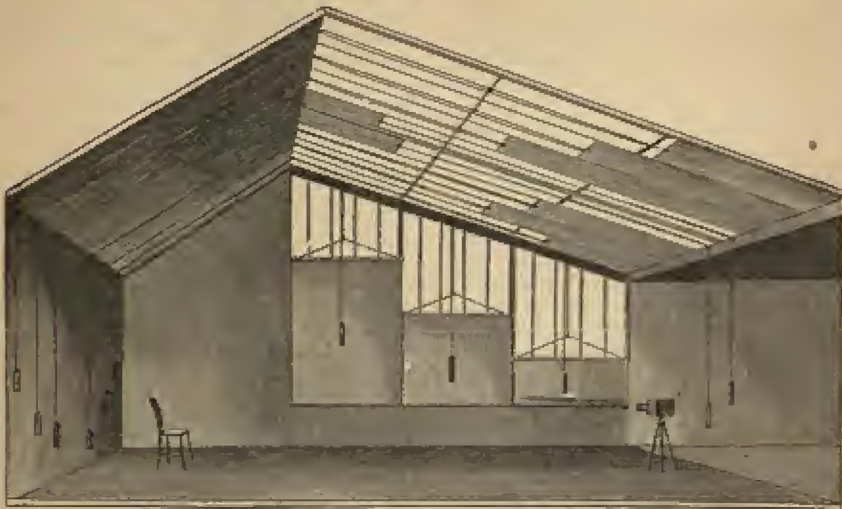


FIG. 189

The diagram (Fig. 188) is of a glass-room of the form largely used in America.

model is placed, and the camera and stand point out the place near which they are

used. The dimensions of the room are as follows:

Width of the side-light . . .	13 feet.
Height of the side-light at the lowest point	6 feet 10 inches.
Height of the side-light at the highest point . . .	11 feet 9 inches.
Distance from the floor to the bottom of the side-light .	14 inches.
Width of the top-light . .	17 feet 6 inches.
Length of the top-light . .	15 feet.
Depth of the room as shown in the diagram	22 feet.

It will be seen that instead of blinds, curtains or shades are used to modify the light at the top and on both sides. By a proper arrangement of weights, pulleys, etc., they are made to change the light as the operator may desire. If the light be too strong from the direction of the top or side, the curtains are drawn so as to soften the shadows and secure such relief as is found requisite. These curtains can be raised or lowered to any extent; so it will be seen that by their use almost any modification of light can be secured. They may be made of blue or white muslin, and therefore admit only the kind of light needed. Experience must teach the proper use of them. On days when the sun shines directly over or into the room, all of the curtains should be drawn over; at other times they may be arranged variously, somewhat as they appear in the diagram.

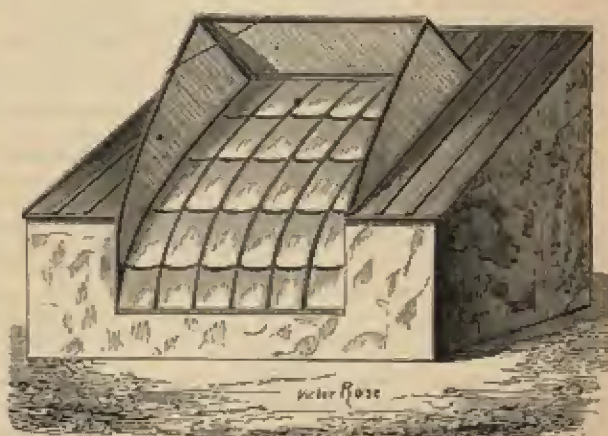
The second diagram (Fig. 189) shows the plan of curtaining and arranging the inside blinds. These are more elaborate than is necessary, but they serve a useful purpose in emergent cases.

Skylight Screen. Device by Mr. G. Cramer. It consists of a frame about the height and size of an ordinary background frame and is mounted on casters. From side to side two rows of heavy iron wire are stretched. On one row white cloth is hung, and on the other, black cloth, the one back of the other. This screen, so placed to the source of light as to intercept it, may be used to increase or decrease the quantity of light at will, or effects may be modified to any degree simply by arranging the screens to suit; or when an open light is desired they may be removed entirely. (See Fig. 190.)

FIG. 190.

Skylight (Cylindrical Form). It is a mooted question as to which form is best for the construction of top side-lights of a

FIG. 191.



studio. One of the best forms, usually, is the half-cylindrical, as shown in the figure, as it provides more evenness and secures greater rapidity under equal conditions of

light. This is due to the continual variation in the position of the sun, because of which it is not possible to adjust the angle to a straight-sided glass roof in such a manner that the light may pass at right angles and with the least disturbance or loss of a portion of its power so easily in any other form as it is with this form of skylight. The extra cost is one great objection to its general adoption. In *Wilson's Photographics*, and in *Wilson's Quarter Century in Photography*, the subject of skylight construction is exhaustively treated and an architect's drawings are given, which can be followed by any builder.

Slide. A name given to lantern transparencies.

Slider. A name sometimes given to the dark-slide or plate-holder, which see.

Sliding Plate-Holder. A plate-holder made to move across the lens so as to secure a multiplication of images without the movement of the objective. One device was patented and caused long and severe legal contests in America.

Smith's Negative Process. The process was devised by Mr. Edward Smith, of England, for the purpose of doing away with the nitrate of silver bath. He first coats a clean glass plate with collodion, containing no iodide or bromide; when dry, or nearly so, he coats it again with an alcoholic solution of iodine about the color of port wine. To make it sensitive pour on the following solution: Alcohol, 1 ounce; distilled water, 1 ounce; nitrate of silver, 10 grains. This must be kept moving *over the plate* until the yellow iodide is formed; when this is complete, drain off and expose; return without loss of time to develop. To accomplish this, first wash until greasiness disappears; then develop with protosulphate of iron, 20 grains; glacial acetic acid, 15 minims; distilled water, 1 ounce. Pour over the plate, and when it flows freely add a few drops nitrate of silver solution. When fully out, wash and fix as usual; it can now be intensified by any of the usual processes. It is important to wash the plate before developing, or the solution would not flow freely; but this is best done after exposure, as the plate is much more sensitive. Mr. Smith has also produced good negatives with albumen, gelatine, etc., treated in the same way.

Soda. (See *Hydriodate and Hyposulphite of Soda, Carbonate and Bicarbonate of Soda*, etc.)

Sodium. The metalic base of soda. It is a soft white metal, scarcely solid at an ordinary temperature, fuses at 200° F., and volatilizes at a red heat; sp. gr. 0.972; its other properties resemble those of potassium, but are of feeble character.

Sodium Bisulphite. Bisulphite of sodium, $NaHSO_3$. Prismatic crystals, very soluble in water, insoluble in alcohol. Reacts acid. Used as preservative of developing agents (being more effective than the neutral sulphite), and in the preparation of the so-called "acid fixing-bath."

Sodium Collodion. The formula for making this collodion, is as follows:

Ether at 0.725	200 parts.
Alcohol 0.815	400 "
Pyroxylin	7 "
Iodide of Sodium	8 "
Iodide of Cadmium	2 "
Bromide of Cadmium	2 "

Sodium Ferric Oxalate. $Fe_2(C_2O_4)Na_6 +$ $11H_2O$. Double salt of ferric oxalate, very soluble in water, light-sensitive. Used in the preparation of platinum paper.

Sodium Oxalate. $Na_2C_2O_4$. Fine shining needles, soluble in twice their weight of boiling and thirty-six times their weight of cold water. Serves as developer in the platinum printing and developing process, and in the platinum printing process without development it is used in the preparation of the paper.

Solar Agency. The influence of the sun's rays upon organic and other substances, by which any change is effected. (See *Light.*)

Solar Beam. A collection of parallel rays of light emanating from the sun.

Solarization. The reversal of the picture through over-exposure. If a film of silver salt is exposed in the camera or under a dispositive beyond a certain limit of time, a positive will result in development in place of a negative. This is the reason why actinically powerful bodies, for instance the sun, if they are included in the picture, appear glass-clear in the negative, and, of course, black in the print. This phenomenon needs further investigation and study.

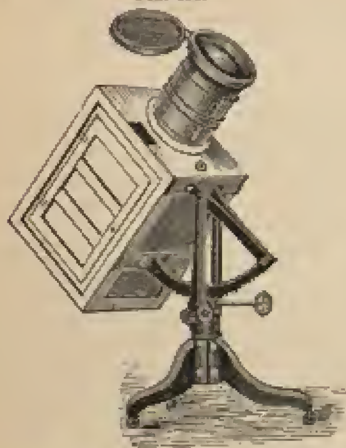
Solarize. To burn up; a photograph is said to be solarized when the action of light has been prolonged to such a degree that the shades, or dark parts, are indistinct and of a grayish appearance, and the light, or white parts are of an iron-bluish appearance in the daguerrotype, and of a uniform white in the paper photograph.

Solar Radiation. The projection of rays of light from the sun.

Solar Rays. The sun's rays of light.

Solar Camera. An enlarging camera supplied with a condenser, which modifies the course of parallel light-rays passing through the objective.

FIG. 192.



There are various forms. The one shown in the diagram is called the direct printing solar camera, and consists of a dark chamber with suitable room inside, together with an objective and condenser, all operated by the changeable mechanism seen below the diagram. By another plan a reflector is used.

Solar Spectroscopy. The study of the solar spectrum, or colored image of the sun produced by refraction through a prism, or by diffraction through a fine grating or ruled screen. In this work modern photography plays an important part.

Solio Paper. A chloride of silver-gelatine printing-out paper, introduced by the Eastman Company.

Soluble. That which may be dissolved; susceptible of being held in solution.

Soluble Cotton. (See *Pyroxylin.*)

Soluble Glass. Water-glass.

Soluble Primrose. One of the iodo-derivatives of fluorescein, used as a color-sensitizer in orthochromatic photography.

Solubilities of Photographic Chemicals, DR. J. H. JANEWAY'S TABLE OF.

(*Abbreviations:* s. soluble; ins. insoluble; sp. sparingly; m. moderately; v. very; dec. decomposed.)

CHEMICALS.	WATER.		Cold Alcohol.
	59° F.	212° F.	
One Part is soluble in—	Parts.	Parts.	
Acid, Citric	0.75	6	v. s.
Gallic	100	3	m. s.
Oxalic	8	1	v. s.
Pyrogallic	2.5	v. s.	v. s.
Tannic	6	v. s.	v. s.
Alum	10.5	v. s.	ins.
Chrome	10	dec.	ins.
Ammonium, Nitrate	0.5	v. s.	v. s.
Chloride	3	v. s.	sp. s.
Carbonate	4	dec.	m. s.
Sulphocyanate	v. s.	v. s.	v. s.
Bromide	1.5	0.7	sp. s.
Iodide	1	0.5	m. s.
Baryta, Nitrate	8	3	
Cadmium, Bromide	v. s.	v. s.	m. s.
Iodide	v. s.	v. s.	v. s.
Copper, Acetate	15	5	sp. s.
Sulphate	2.6	0.5	ins.
Gold, Chloride	v. s.	v. s.	v. s.
and Sodium Chloride	v. s.	v. s.	m. s.
Iron, Perchloride	v. s.	v. s.	v. s.
Protosulphate	1.8	0.3	ins.
and Ammonia sulphate	3	0.8	ins.
Iodide (Ferrous)	v. s.	v. s.	sp. s.
Iodine	7000	——	m. s.
Kaolin	ins.	ins.	ins.
Lead, Acetate	1.8	0.5	m. s.
Chloride	v. sp.	33	ins.
Nitrate	2	0.8	ins.
Lithium, Bromide	v. s.	v. s.	m. s.
Iodide	v. s.	v. s.	m. s.
Magnesia, Nitrate	v. s.	v. s.	m. s.
Mercury, Bichloride	16	2	v. s.
Cyanide	12.8	3	ins.
Potassium, Acetate	0.4	v. s.	v. s.
Bicarbonate	3.2	dec.	ins.
Bichromate	10	1.5	ins.
Bromide	1.6	1	sp. s.
Carbonate	1	0.7	ins.
Cyanide	2	1	m. s.
Ferricyanide	3.8	2	ins.
Ferrocyanide	4	2	ins.
Nitrate	4	0.4	ins.
Iodide	0.8	0.5	m. s.
Oxalate	3	v. s.	ins.
Permanganate	20	3	ins.
Sulphate	9	4	ins.
Sulphite	4	5	sp. s.
Sulphuret	2	1	sp. s.
Silver, Nitrate	0.8	0.4	m. s.
Oxide	v. sp. s.	v. sp. s.	ins.
Sodium, Acetate	3	1	m. s.
Bromide	1.2	0.5	m. s.
Bicarbonate	12	dec.	ins.
Carbonate	1.6	0.25	ins.
Citrate	v. s.	v. s.	sp. s.
Hyposulphite	1	v. s.	ins.
Iodide	0.6	0.3	m. s.
Nitrate	1.3	0.6	sp. s.
Phosphate	6	2	ins.
Pyrophosphate	12	1.1	ins.
Sulphite	4	0.9	sp. s.
Sulphate	2.8	0.4	ins.
Tungstate	4.0	2.0	ins.
Strontia, Chloride	1.88	v. s.	sp. s.
Uranium, Nitrate	v. s.	v. s.	m. s.
Zinc, Iodide	v. s.	v. s.	m. s.
Bromide	v. s.	v. s.	m. s.
Chloride	0.33	v. s.	v. s.

Solution. A feeble combination, in which, with a mere mechanical change of properties and without regard to the definite proportions, one or more solids are equally diffused through some liquid. This mode of combination is so weak that the liquid may be evaporated from the solid or solids, leaving them unchanged except in texture or aggregation. There is usually, and probably always, a limit to the quantity of solid or solids which can be dissolved by a given liquid, and this is called *saturation*. The liquid in which the solution is effected is called the *solvent* or *menstruum*. The term solution is applied to a very extensive class of phenomena. When a solid disappears in a liquid, if the compound exhibits perfect transparency, we have an example of solution. The word is applied both to the *act* of combination and to the result of the process. Thus, common salt disappears in water, that is, its *solution* takes place, and the liquid obtained is called *a solution of salt water*. Solution is the result of attraction, or affinity between the fluid and the solid. The affinity continues to operate to a certain point, where it is overbalanced by the cohesion of the solid; it then ceases and the fluid is said to be *saturated;* the point where the operation ceases is called *saturation*, and the fluid is called a *saturated solution*. *Solution* is a true chemical union; *mixture* is a mere chemical union of bodies. When solids are to be dissolved, subdivision helps solution, therefore many solids dissolve better if powdered. Some solids decompose if heated. Such should be dissolved in cold water. It is generally safer to use warm rather than hot liquids in dissolving substances used in photography; whenever possible, distilled water should be employed to obviate impurities in the solution.

Solvent. A reducer to the liquid aggregate state, without disintegration, so that the solid may be regained by evaporation of the solvent.

Sound-Photography. M. Leon Esquine, a French-Mexican savant, is said to have perfected a marvellous instrument for photographing speech. By speaking into a photophone transmitter, which consists of a highly polished diaphragm reflecting a ray of light, the ray of light itself is set into rapid vibrations, and a photograph is made of the sound of the voice as it travels along a band of sensitized paper. If the image of the photographic tracing is projected by means of an electric arc or oxy-hydrogen light upon a selenium receiver, the original speech is instantly emitted from the tube of the receiver, and may be heard as plainly as if uttered by a human being in an ordinary tone of voice. The kineotograph of Mr. Edison is the latest development in this direction.

Specific Gravity. By *specific gravity* is meant the relative weight of substances compared with some standard. In the case of solids and liquids, the weight of the body is compared with water as unity; that is, if a given quantity of water by measure be weighed, and that weight represented by 1, the weight of an equal quantity by measure of any other substance is compared with it. In the case of gases, air is taken for the standard of comparison or for unity, and an equal quantity of any other gas is weighed and compared with it. The density for specific weight of solid bodies differs very much, as may be seen by weighing equal bulks of different metals or other substances. When *liquids* are to be weighed, take a bottle, weigh it empty and note the amount, then fill it with distilled water and weigh again with great accuracy; pour out the water and dry the bottle well, weigh it again to see that it is as in the first instance, after which fill it with the fluid the weight of which is to be ascertained. The following proportions will give its specific gravity: for example, if the distilled water weighs 100 grains, and the liquid 150, we must make use of

$$100 : 150 :: 1 : 1.5.$$

Solid bodies are weighed in the following manner: weigh the substance first in the air, then suspend it to the beam of a balance by a fine hair, and weigh it in a glass full of water; a quantity of water equal to the bulk of the solid will be displaced and the following proportions will give the specific gravity in relation to water: As the weight of the water is equal in bulk to that of the solid itself, so is the specific gravity of the water to the specific gravity of the solid; for instance, if a solid weigh 200 grains in the air and 150 grains in water, then 200 — 150 or 50 : 200 :: 1 : 4. The specific gravity of the solid is consequently 4, compared with that of water. When the solid body to be weighed is lighter than water, a weight sufficient to sink the lighter body must be

attached to it. Having previously weighed the heavier solid in water, and each in air, they are next to be weighed together in water, and from the difference between their weight in air subtract the difference between the weight of the heavier solid in air and its weight in water; the remainder will show the weight of a quantity of water equal in bulk to the light body. If the weight of the light body be 10 and of the heavy solid 20; and if the heavy solid in water be 14 and the two together 6, then

From their weight in air $10 + 20 =$	30
Subtract their weight in water	7
	23
And from this subtract $20 - 14 =$	6
	17

This last number (17) will express the weight of a quantity of water equal in bulk to the light solid, and the following proportions will give the specific gravity: 17 : 10 : : 1 : 0.588236, the specific gravity of the lighter body. If the solid body should be soluble in water, some other fluid in which it is insoluble must be employed; the specific gravity of the fluid itself being first ascertained and used as a standard of comparison and making the number representing its specific gravity the third term in the proportion, in the same manner as when water is used, and then by simple proportion reduce the product to the standard of water. (See *Hydrometer* and *Actinometer*.)

Specific Heat. The time required for a body to cool from a certain temperature to another given one while in a polished silver receptacle in a vacuum.

Specific Weight. The number which indicates how much heavier or lighter a body is than its equal volume of another body. For solid and liquid bodies these numbers relate to distilled water in its greatest density as the unit: 1 cubic centimetre (c.cm.) of water, *i. e.* = 1 gramme (gm.); an equal volume of sulphuric acid weighs 1.842 gm., this number indicating the density of this acid. For the determination of the specific gravity of liquids the areometer or hydrometer is used.

Specimen. A daguerrotype or photograph designed for exhibition as a sample of the artist's skill.

Spectro-Heliograph. An ingenious instrument combining a camera and spectroscopic apparatus, devised by Prof. Hale, and used by him to secure a complete picture of the sun, showing spots, faculæ, and solar prominences upon one plate.

Spectroscope. An instrument employed in the analysis of the solar spectrum. When arranged ready for use, it forms a graceful-looking instrument in polished brass, consisting of two thin tubes about 4 inches long, diverging at an angle in opposite directions from a central chamber, which contains the prisms. The slit itself is furnished with a double movement; one, by means of a screw, altering its width from $\frac{1}{16}$ of an inch to the $\frac{1}{1000}$, or even less, until the knife edges close altogether; the other raising or lowering the entire slit, without affecting its width, so that with the highest magnifying powers the whole of the solar spectrum may be successively brought into the field of view. The other tube on the opposite side of the prism-chamber forms a telescope which is fitted with eye-pieces of different powers. When closed it packs in a morocco case not more than $4\frac{3}{4}$ by $2\frac{3}{4}$ inches square, and $1\frac{1}{4}$ inches thick. The method of using this instrument is very simple. The two tubes merely require screwing into their places in the prism-box, the slit adjusted to the proper width, and the telescope brought to the proper focus, when the observer may at once see the spectrum of any source of light to which the tube carrying the slit is pointed. Thus it is only necessary to place in front of the slit a spirit or gas lamp, burning with a colorless flame, and then introduce into the outer envelope of the flame a fine platinum wire, having on its extremity a portion of some soda compound, when the brilliant line characteristic of this element at once flashes across the field of view and remains there so long as the smallest particle of soda continues to be present on the wire. This instrument is found very useful in the analysis of water, and the various iodizing compounds in use, and in testing the value of colored glasses for photographic purposes.

Spectroscope Rainband. This useful little instrument, obtainable commercially, should be carried by every landscape worker, as by its aid the weather can be foretold hours in advance, and a profitless day of travel often saved. The following rules for its use may be acceptable:

1. Adjust the focus and slit of the spectroscope so that lines of the spectrum may be

of the clearest definition, and while taking an observation shade the eyes with the hands to exclude all extraneous light.

2. Observations should be made generally 10° to 20° from the horizon and toward the quarter from which the wind is blowing, but if not possible, point the instrument northerly in preference to a southerly direction.

3. If now 80 per cent. of the dark band be shown at zenith, heavy rain is near at hand, despite the contradiction in appearance of the weather.

4. If during wet weather the rainband runs low, fine weather is near.

5. If the instrument be directed toward the point from which the wind is blowing, and should clouds be passing and still 20 per cent. or less of rainband be shown, no rain for at least six hours may be looked for, despite the threatening appearance of the sky. Read *Aids to Study and Forecasts of Weather*, by W. C. Sey, M.A.—*C. Ashleigh Snow.*

Spectrum. Prismatic or rainbow colors, which result when white light is made to pass through a glass prism and to fall upon a white surface. The white light is thus dissolved into its several component colors. They appear in the following order: red, orange, yellow, green, blue, indigo, violet.

Spectrum Analysis. The German savants, Bunsen and Kirchhoff, introduced the use of the spectrum in chemical analysis, and by means of this discovery the composition of terrestrial matter has become revealed to us with a degree of accuracy and delicacy before unheard of; so that chemical elements supposed to be of rare and singular occurrence are shown to be most commonly and widely distributed. The importance of these researches becomes still more strikingly apparent when we learn that the conclusions derived from them outstep the bounds of our planet, enabling us to determine with all the certainty of definite experiment the actual presence of a number of elementary bodies in the stars. The colors which certain bodies impart to flame have long been used by chemists as a test for the presence of such bodies. Thus, soda brought into a colorless flame produces a bright yellow light, and substances containing soda in any form give this yellow color. Potash gives a violet flame, lithia and strontia impart to flame a crimson color, whilst salts of barium tinge it green. These colors are produced by the incandescence or luminosity of the heated vapor of the various bodies placed in the flame. It is only because these substances are volatile or become gases at the temperature of the flame that we observe the peculiar color. If any substance, such as platinum, which is not volatile at the temperature of the flame, be placed in it, no coloration is observed. The higher the temperature of the flame in which the same substance is introduced, the greater will be the luminosity; and the more volatile the salt of the same metal the more intense is the light produced. Heated to the point of incandescence in any other manner, the vapors of these metals and their salts give out the same colored light. Thus, if we burn guncotton, or gun-paper, steeped in various solutions of these salts, we get the characteristic colors. These facts had long been known and applied; but it was reserved for for Bunsen and Kirchhoff to place these beautiful phenomena in their true position and to apply to them the modern method of exact research, and thus to open out a new and rich field for most important investigations. This they accomplished in the most simple and beautiful manner by examining these colored flames, not only by the naked eye, but by means of a prism or an apparatus for separating, decomposing, or splitting up into into its different parts the light produced by the incandescent vapor. If we pass white sunlight through a prism we get the well-known solar spectrum discovered by Newton. If, instead of using white sunlight we pass the rays from the yellow soda flame through the prism we get the soda spectrum, and we find that instead of a continuous spectrum all we see is one bright yellow line, showing that every kind of light except the bright yellow ray is absent in the soda flame—or that the soda flame gives but one *kind* of light. As each metal—sodium, calcium, potassium, lithium, strontium, barium, etc.—communicates a distinct tint to flame, so each gives a distinct and characteristic spectrum, consisting of certain bright colored lines or bands of light of the most peculiar form and tint. In each spectrum of these metals the form, number, position, color, and tone of the bright lines remain perfectly constant and unvarying; so that from the presence or absence of one of these lines we may, with absolute certainty, draw conclusions respecting the presence or absence of the particular metal, as we know of

no two substances which produce the same bright lines. None of the bright lines produced by any one metal interfere in the least with those of any other; and in a mixture of all these metallic salts together each ingredient can thus be easily detected, and the most minute quantity of any one substance can be observed.—*Roscoe.* (See *Spectroscope.*)

Spectrum Camera. An instrument devised by Mr. Crookes for forming the solar spectrum in a state of purity.

Spectrum Photography. Photographing the spectra of the stars, effected by apparatus contrived for that purpose especially. For particulars refer to the contributions of Prof. Schumann in *Photographic Mosaics* for several years back.

Speculum. A mirror employed in optical instruments, in which the reflecting surface is formed of a metallic alloy, instead of glass coated with quicksilver. For ordinary purposes, however, glass mirrors are sometimes used. The speculum is attached to the photographic camera, either upon the end of the tube or within the box, to enable the operator to reverse the image upon the ground-glass or spectrum and bring it to its natural position.

Spherical Aberration. This kind of aberration is attributed to the incident rays not being equally refracted through different parts of the lens, the rays nearest the axial rays being less refracted than the marginal rays, consequently they are collected at different foci; the result being a confused image of the object on the glass, bright and sharp in the centre, but gradually passing off into a hazy halo toward the edge. This is dependent on the form of the lens—the greater its convexity, or the greater the inequality of the curves of its two faces with reference to the direction of the incident rays, the greater will be the spherical aberration; it is, therefore, less in a lens of periscopic form, which renders the marginal rays longer than the axial rays when the concave side is presented to the object. Spherical aberration is further corrected by placing a *diaphragm* or "stop" at such a distance before the lens that it will just admit the rays of light from the object and thus exclude the marginal rays. In proportion, however, as we decrease the size of the aperture of the diaphragm we increase the sharpness of the image and the size of the field, but the operation of exposing the sensitive surface is prolonged in consequence of the amount of light thus cut off. This decrease of power by the use of diaphragms is generally in the proportion of 1, 4, 8; thus, as an illustration, if the largest opening gave a picture in one second, a diaphragm with an opening one-fourth smaller would require four times as long, and one-half the size eight times as long to produce the same effect. (See *Lens.*)

Spirit Lamp. A lamp for burning alcohol; either of glass or Britannia metal.

Spirits of Wine. (See *Alcohol.*)

Spots on the Collodion Film. (See *Imperfections in Collodion Negatives and Positives.*)

Squeegee. A mounting roller or print mounter; a small rotating roller covered with rubber, supplied with a handle and used for mounting prints; still better are double rollers.

Stains. (See *Imperfections in Collodion Negatives and Positives.*)

Stand. Tripod, a light but firm three-legged frame, which can be lowered or raised, upon which the camera rests. Can be folded up, or taken apart (see *Portable Stand*). In placing the tripod, when about to take a picture, the legs are arranged about equidistant and with their sharp points firmly fixed in the ground, one leg pointing toward the object to be photographed, the operator, when focussing, taking position between the others, drawing the front leg toward himself, when he wishes to point the camera higher, and placing it farther away if the reverse.

Stanotype. A simplification of the Woodbury process, inasmuch as in this process no hydraulic press is required, only a small iron hand-press, with overlapping rollers. The gelatine relief-picture is pressed into tin-foil, from which the prints are made.

Starch. Amylum. $C_6H_{10}O_5$. The farina or fecula of various vegetables; a white substance with no smell and very little taste, and which, when squeezed between the fingers, gives a very peculiar sound. It forms the greater portion of all farinaceous substances. It is insoluble in cold water, alcohol, or ether; but if boiling water is poured upon starch rubbed up in cold water a paste or jelly is formed, very nearly transparent, which is used for mounting photo-

graphs. The starch contained in arrowroot is the purest, giving, when boiled in water, an almost clear solution. Arrowroot is used in the preparation of arrowroot paper. Pure starch, dissolved in boiling water, is rendered insoluble in cold water by drying. This property of starch is useful for giving a perfect sizing to paper. The most suitable starch for this operation is obtained by the boiling of rice, starch from which remains dissolved in the boiling water. It contains at the same time gluten, which renders it better than the starch of commerce. By adding the mucilage of linseed to rice-water in the proportion of one-third, a still firmer sizing is obtained. Starch has a very great affinity for iodine, and almost always separates it from the base with which it may be united. This combination communicates a blue color to starch, and it is this property which enables us to recognize the presence of iodine in a liquid by using starch as a test.

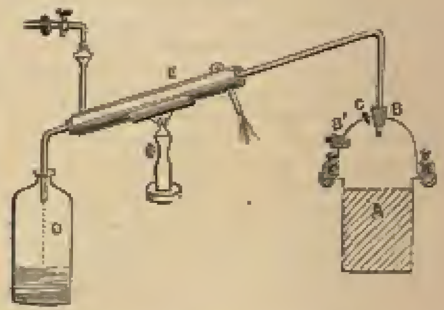
Starch-Iodide Test. Employed to detect the presence of hypo soda in washing-waters. A piece of starch about the size of a pea is boiled in a quarter of an ounce of water until a clear solution is obtained. To this is added one drop of tincture of iodine, producing a dark-blue color. Fill one test-tube with distilled water, and a second with the water to be tested, and add to each one drop of the blue solution. Compare the two tubes, and if the blue color of the one has disappeared it is a proof that hypo soda is present. If a weak solution of potassium iodide (2 grains in a pint of water) is brushed over a toned and fixed print at the back, the appearance of a blue tint will indicate the *absence* of hypo soda.

Star Stop. Diaphragms in the form of a star, used with objectives showing a considerable decrease of illumination from the centre to the edges (wide angles), to afford a longer exposure in the weaker parts than in the middle of the lens. After a partial exposure the star-stop is moved close to the centre of the objective till full exposure is made. The rays of the star should not be wider than half the opening of the smallest stop. In the middle of the star a black circle is left of about two-thirds of the diameter of the lens. The rays are so long as to act close up to the field of vision.

Stearic Glucose. The ordinary glucose treated with stearic acid at a temperature of 250° F. for forty or fifty hours. The same result is obtained when cane-sugar or treacle is substituted for ordinary glucose. Stearic glucose is a neutral, colorless, solid substance, of a waxy consistence, resembling stearin in appearance. It is very soluble in ether and in absolute alcohol, but insoluble in water. When it is shaken up in alcohol it yields an opalescent mixture like a weak emulsion. It reduces cupro-potassic tartrate, and becomes strongly colored in contact with concentrated sulphuric acid. Heated with a mixture of hydrochloric acid and alcohol, it is decomposed into stearic ether, fermentiscible glucose and humoidal matter.

Stebbing's Still. A is a copper boiler with a dome, B B′ two funnel-shaped holes in which are inserted corks, C a small hole

FIG. 193.

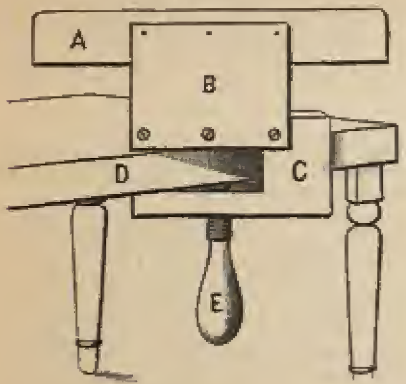


also corked. To set the apparatus at work fill up the boiler with the exact quantity of water which the large bottle D can hold. Fit into the plug B the condensing apparatus E, stop up the holes in the plugs B′ C with corks and light the fire or gas under the boiler. By looking at the bottle, D, it can easily be seen how much the water has diminished in the boiler. The boiler can easily be refilled if required, by taking out the cork C and using a funnel in its place. Water containing alcohol may be distilled in this manner also, but on no account must water containing a mixture of alcohol and ether be so distilled.

Steel Edge for Smoothing Albumen Paper. A is a strip of steel with smoothly ground edge fastened firmly in the block B to the table D by means of the under clamp C. The strip may be, say, a foot long, the

sensitized paper being cut to size for use. It is drawn, plain side down, from end to end over the steel edge, in the same manner as one would iron a ribbon on a stove-pipe.

FIG. 191.



In this manner all the ragged edges of the paper are removed and thus prevented from scratching the negatives.

Steinbach or Saxe Paper. Photographic raw or plain paper, made by Steinbach at Malmédy.

Stenochromy. A method of coloring Woodbury prints devised by Mr. Ingerstein. Not now used.

Stenope Finder. It consists of a stenope having four openings on a turning-plate; to these four openings correspond four simple lenses, suitably diaphragmed and of focal length corresponding to the distances in which the maximum sharpness of each of the openings is found, the openings most used being of three-tenths, five-tenths, four-tenths, and six-tenths of a millimetre; the lenses have respectively eleven, twenty, thirty, and forty-five centimetres of focal length. The plate is placed by means of a lens, and a figure shows itself at a little window, indicating the corresponding opening marked with the same figure. It suffices to turn the plate to bring this opening to its place and mask the lenses at the time. It is evident that these, not being intended to produce the image on the sensitive plate, need not be achromatic, and consequently their use can only increase the price of the apparatus, but to an insignificant degree. The time of exposure presents much less difficulty than with objectives.

Stereograms (Stereographs.) Names given to photographic stereoscopic pictures. Two similar pictures mounted upon one cardboard, by viewing which in the stereoscope a single picture in strong relief is produced. (See *Stereoscopic Printing.*)

Stereography. The art of producing stereographs or pictures to be seen in relief in the stereoscope. The art of stereography has been a subject of considerable controversy among writers on photography, but the discussions which have been the consequence have introduced such improvements into the practical methods that it has become narrowed down to definite limits. The manipulations in stereography are the same with the binocular camera as for single negatives. (See *Stereoscopic Angle; Stereoscopic Camera; Stereoscopic Printing; Stereoscopic Slides; Stereoscopic Transparencies, and Stereoscopic Vision.*

Stereo-Photography. Stereoscopic photography. The making of stereoscopic pictures by means of photography. The exposure is made with a stereoscopic camera, but can also be made with a common camera if, after the first exposure, it is moved sideways a certain distance corresponding to the space or distance between the axis of the eyes. In mounting, the picture taken on the right side must be placed on the right, and the one taken on the left side, on the left of the mount. When a larger number of prints is required, some cut the negative in two, interchange the halves and fasten them upon a clean glass plate.

Stereoscope. An optical instrument for representing, in apparent relief and solidity, all natural objects and all groups or combinations of objects, by uniting into one image two plane representations of those objects or groups as seen by each eye separately. In its most general form the stereoscope is a *binocular* instrument, that is, is applied to *both* eyes; but in two of its forms it is *monocular*, or applied only to *one* eye, though the use of the other eye, without any instrumental aid, is necessary in the combination of the two plane pictures, or of one plane picture and its reflected image. The stereoscope, therefore, cannot, like the telescope and microscope, be used by persons who have lost the use of one eye, and its remarkable effects cannot be properly appre-

ciated by those whose eyes are not equally good.

When the artist represents living objects, or groups of them, and delineates buildings or landscapes, or when he copies from statues or models, he produces apparent solidity, and difference of distance from the eye, by light and shade, by the diminished size of known objects as regulated by the principles of geometrical perspective, and by those variations in distinctness and color which constitute what has been called aërial perspective. But when all these appliances have been used in the most skilful manner, and art has exhausted its powers, we seldom, if ever, mistake the plane picture for the solid which it represents. The two eyes scan its surface, and by their distance-giving power indicate to the observer that every point of the picture is nearly at the same distance from his eye. But if the observer closes one eye, and thus deprives himself of the power of determining differences of distance by the convergency of the optical axes, the relief of the picture is increased. When the pictures are truthful photographs, in which the variations of light and shade are perfectly represented, a very considerable degree of relief and solidity is thus obtained; and when we have practised for a while this species of monocular vision, the drawing, whether it be of a statue, a living figure, or a building, will appear to rise in its different parts from the canvas, though only to a limited extent.

In these observations we refer chiefly to ordinary drawings held in the hand, or to portraits and landscapes hung in rooms and galleries, where the proximity of the observer, and lights from various directions, reveal the surface of the paper or the canvas; for in panoramic and dioramic representations, where the light, concealed from the observer, is introduced in an oblique direction, and where the distance of the picture is such that the convergency of the optic axes loses much of its distance-giving power, the illusion is very perfect, especially when aided by correct geometrical and aërial perspective. But when the panorama is illuminated by light from various directions, and the slightest motion imparted to the canvas, its surface becomes distinctly visible, and the illusion instantly disappears.

The effects of stereoscopic representation are of a very different kind, and are produced by a very different cause. The singular relief which it imparts is independent of light and shade, and of geometrical as well as of aërial perspective. These important accessories, so necessary in the visual perception of the drawings *in plano*, avail nothing in the evolution of their *relievo*, or third dimension. They add, doubtless, to the binocular pictures; but the stereoscopic creation is due solely to the superposition of the two plane pictures by the optical apparatus employed, and to the distinct and instantaneous perception of distance by the convergency of the optic axes upon the similar points of the two pictures which the stereoscope has united.

If we close one eye while looking at photographic pictures in the stereoscope, the perception of relief is still considerable, and approximates to the binocular representation; but when the pictures are mere diagrams consisting of white lines upon a black ground, or black lines upon a white ground, the relief is instantly lost by the shutting of the eye; it is only with such binocular pictures that we see the true power of the stereoscope.

As an amusing and useful instrument the stereoscope derives much of its value from photography. The most skilful artist would have been incapable of delineating two equal representations of a figure or a land-cape as seen by two eyes, or as viewed from two different points of sight; but the binocular camera, when rightly constructed, enables us to produce and to multiply photographically the pictures which we require, with all the perfection of that interesting art. With this instrument, indeed, even before the invention of the daguerrotype and the Talbotype, we might have exhibited temporarily upon ground-glass, or suspended in the air, the most perfect stereoscopic creations, by placing a stereoscope behind the two dissimilar pictures formed by the camera.

When we look with both eyes open at a sphere, or any other solid object, we see it by uniting into one, two pictures, one as seen by the right, and the other as seen by the left eye. If we hold up a thin book perpendicularly, and midway between both eyes, we see distinctly the back of it and both sides with the eyes open. When we shut the right eye we see with the left eye the back of the book and the left side of it, and when we shut the left eye we see with the right

eye the back of it and the right side. The picture of the book, therefore, which we see with both eyes, consists of *two* dissimilar pictures united, namely, a picture of the back and left side of the book as seen by the left eye, and a picture of the back and right side of the book as seen by the right eye.

In this experiment with the book, and in all cases where the object is near the eye, we not only see *different pictures* of the same object, but we see *different things* with each eye. Those who wear spectacles see only the left-hand spectacle-glass with the left eye, on the left side of the face, while with the right eye they see only the right-hand spectacle-glass on the right side of the face, both glasses of the spectacles being seen united midway between the eyes, or above the nose, when both eyes are open. It is, therefore, a fact well known to every person of common sagacity that *the pictures of bodies seen by both eyes are formed by the union of two dissimilar pictures formed by each.*

This palpable truth was known and published by ancient mathematicians. Euclid knew it more than two thousand years ago.

More than fifteen hundred years ago, the celebrated physician Galen treated the subject of binocular vision more fully than Euclid. In the twelfth chapter of the tenth book of his work, *On the Use of the Different Parts of the Human Body*, he has described with great minuteness the various phenomena which are seen when we look at bodies with both eyes, and alternately with the right and the left. He shows, by diagrams, that dissimilar pictures of a body are seen in each of these three modes of viewing it; and after finishing his demonstration, he adds:

"But if any person does not understand these demonstrations by means of lines, he will finally give his assent to them when he has made the following experiment: Standing near a column, and shutting each of the eyes in succession; when the *right* eye is shut, some of those parts of the column which were previously seen by the *right* eye on the *right* side of the column, will not now be seen by the *left* eye; and when the *left* eye is shut some of those parts which were formerly seen by the *left* eye on the *left* side of the column, will not now be seen by the *right* eye. But when we, at the same time, open both eyes, both these will be seen, for a greater part is concealed when we look with either of the two eyes, than when we look with both at the same time."

In such distinct and unambiguous terms, intelligible to the meanest capacity, does this illustrious writer announce the fundamental law of binocular vision—the grand principle of the stereoscope, namely, *the picture of the solid column which we see with both eyes is composed of two dissimilar pictures, as seen by each eye separately.* As the vision of the solid column, therefore, was obtained by the union of these dissimilar pictures, an instrument only was wanted to take such pictures, and another to combine them. The binocular photographic camera was the one instrument, and the stereoscope the other.

The subject of binocular vision was studied by various optical writers who have flourished since the time of Galen. Baptista Porta, one of the most eminent of them, repeats, in his work *On Refraction*, the propositions of Euclid on the vision of a sphere with one and both eyes, and he cites from Galen the very passage which we have given above on the dissimilarity of the three pictures seen by each eye and by both. Believing that we see only with one eye at a time, he denies the accuracy of Euclid's theorems, and while he admits the correctness of the observations of Galen, he endeavors to explain them upon other principles.

In illustrating the views of Galen on the dissimilarity of the pictures which are requisite in binocular vision, he employs a much more distinct diagram than that which

FIG. 195.

is given by the Greek physician. "Let A "(Fig. 195), he says," be the pupil of the right eye, B that of the left, and D C the body to be seen. When we look at the object with both eyes we see D C, while with the left eye we see E F, and with the right eye G H. But if it is seen

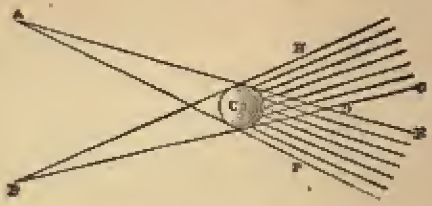
with one eye, it will be seen otherwise, for when the left eye, B, is shut, the body C D, on the left side, will be seen in H G; but when the right eye is shut, the body C D will be seen in F E; whereas, when both eyes are opened at the same time, it will be seen in C D." These results are then explained by copying the passage from Galen, in which he supposes the observer to repeat these experiments when he is looking at a solid column.

In looking at this diagram, we recognize at once not only the principle, but the construction of the stereoscope. The double stereoscopic picture or slide is represented by H E; the right-hand picture, or the one seen by the right eye, by H F: the left-hand picture, or the one seen by the left eye, by G E; and the picture of the solid column in full relief by D C, as produced midway between the other two dissimilar pictures, H F and G E, by their union, precisely as in the stereoscope.

Galen, therefore, and the Neapolitan philosopher, who has employed a more distinct diagram, certainly knew and adopted the fundamental principle of the stereoscope; and nothing more was required, for producing pictures in full relief, than a simple instrument for uniting H F and G E, the right and left hand dissimilar pictures of the column.

In the treatise on painting which he left behind him in MS., Leonardo da Vinci has made a distinct reference to the dissimilarity of the pictures seen by each eye as the reason why "a painting, though conducted with the greatest art, and finished to the last perfection, both with regard to its contours, its lights, it shadows, and its colors, can never show a *relievo* equal to that of the natural objects, unless these be viewed at a distance and with a single eye," which he thus demonstrates. "If an object C (Fig. 196) be viewed by a single eye at A, all objects in the space behind it—included, as it were, in a shadow E C F, cast by a candle A—are invisible to an eye at A; but when the other eye at B is open, part of these objects become visible to it; those only being hid from both eyes that are included, as it were, in the double shadow C D, cast by two lights at A and B and terminated in D; the angular space F D G, beyond D, being always visible to both eyes. And the hidden space C D is so much the shorter as the object C is smaller and nearer to the eyes. Thus he observes that the object C, seen with both eyes, becomes, as it were, transparent, according to the usual definition of a transparent thing,

FIG. 196.



namely, that which hides nothing beyond it. But this cannot happen when an object, whose breadth is bigger than that of the pupil, is viewed by a single eye. The truth of this observation is, therefore, evident, because a painted figure intercepts all the space behind its apparent place, so as to preclude the eyes from the sight of every part of the imaginary ground behind it." "Hence," continues Dr. Smith, "we have one help to distinguish the place of a near object more accurately *with both eyes than with one*, insomuch as we see it more detached from other objects beyond it, *and more of its own surface, especially if it be roundish.*"

We have quoted this passage, not from its *proving* that Leonardo da Vinci was acquainted with the fact that each eye, A, B, sees dissimilar pictures of the sphere C, but because it has been referred to by Mr. Wheatstone as the only remark on the subject of binocular vision which he could find "after looking over the works of many authors who might be expected to have made them." We think it quite clear, however, that the Italian artist knew as well as his commentator, Dr. Smith, that each eye, A and B, sees dissimilar parts of the sphere C. It was not his purpose to treat of the binocular pictures of C, but his figure proves their dissimilarity.

The subject of binocular vision was successfully studied by Francis Aguillon or Aguillonius, a learned Jesuit, who published his *Optics* in 1613. In the first book of his work, where he is treating of the vision of solids of all forms (*de genere illorum quæ τὰ στέρεα (ta sterea) nuncupantur*), he has some difficulty in explaining—and fails to do it—

why the two dissimilar pictures of a solid, seen by each eye, do not, when united, give a confused and imperfect view of it. This discussion is appended to the demonstration of the theorem, "that when an object is seen with two eyes, two optical pyramids are formed whose common base is the object itself, and whose vertices are in the eyes," and is as follows:

"When one object is seen with two eyes, the angles at the verticals of the optical pyramids (namely, H A F, G B E, in Fig. 195), are not always equal, for beside the direct view in which the pyramids ought to be equal, into whatever direction both eyes are turned, they receive pictures of the object under unequal angles, the greatest of which is that which is terminated at the nearer eye, and the lesser that which regards the remoter eye. This, I think, is perfectly evident; but I consider it as worthy of admiration, how it happens that bodies seen by both eyes are not all confused and shapeless, though we view them by the optical axes fixed on the bodies themselves. For greater bodies, seen under greater angles appear lesser bodies under lesser angles. If, therefore, one and the same body which is in reality greater with one eye, is seen less on account of the inequality of the angles in which the pyramids are terminated (namely, H A F, G B E, Fig. 195), the body itself must assuredly be seen greater or less at the same time, and to the same person that views it; and, therefore, since the images in each eye are dissimilar (*minime sibi congruunt*) the representation of the object must appear confused and disturbed (*confusa ac perturbata*) to the primary sense."

"This view of the subject," he continues, "is certainly consistent with reason, but, what is truly wonderful, is that it is not correct, for bodies are then seen clearly and distinctly with both eyes when the optic axes are converged upon them. The reason of this, I think, is, that the bodies do not appear to be single, because the apparent images, which are formed from each of them in separate eyes exactly coalesce (*sibi mutuo exacte congruunt*), but because the common sense imparts its aid equally to each eye, exerting its own power equally in the same manner as the eyes are converged by means of their optical axes. Whatever body, therefore, each eye sees with the eyes conjoined, the common sense makes a single motion, not composed of the two which belong to each eye, but belonging and accommodated to the imaginative faculty to which it (the common sense) assigns it. Though, therefore, the angles of the optical pyramids which proceed from the same object to the two eyes, viewing it obliquely, are unequal, and though the object appears greater to one eye and less to the other, yet the same difference does not pass into the primary sense if the vision is made only by the axes, as we have said, but if the axes are converged on this side or on the other side of the body, the image of the same body will be seen double, as we shall show in Book IV., on the fallacies of vision, and the one image will appear greater and the other less on account of the inequality of the angles under which they are seen."

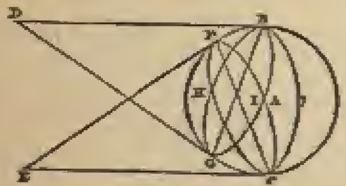
Such is Aguillonius' theory of binocular vision, and of the union of the two dissimilar pictures in each eye by which a solid body is seen. It is obviously more correct than that of Dr. Whewell and Mr. Wheatstone. Aguillonius affirms it to be contrary to reason that two dissimilar pictures can be united into a clear and distinct picture, as they are actually found to be, and he is therefore driven to call in the aid of what does not exist, a *common sense*, which rectifies the picture. Dr. Whewell and Mr. Wheatstone have cut the Gordian knot by maintaining what is impossible, that in binocular and stereoscopic vision a long line is made to coincide with a short one, and a large surface with a small one; and in place of conceiving this to be done by a common sense overruling optical laws, as Aguillonius supposes, they give to the tender and pulpy retina, the recipient of ocular pictures, the strange power of contracting or expanding itself in order to equalize unequal lines and inequal surfaces!

In his fourth and very interesting book, on the fallacies of distance, magnitude, position, and figure, Aguillonius resumes the subject of the vision of solid bodies. He repeats the theorems of Euclid and Gassendi on the vision of the sphere showing how much of it is seen by each eye, and by both, whatever be the size of the sphere and the distance of the observer. At the end of the theorems, in which he demonstrates that when the diameter of the sphere is equal to the distance between the eyes we see exactly a hemisphere, he gives the annexed

drawing (Fig. 197) of the mode in which the sphere is seen by each eye, and by both.

In this diagram E is the right eye and D the left, C H F I the section of that part of the sphere B C which is seen by the right eye E, B H G A the section of the part which is seen by the left eye D, and B L C the half of the great circle which the section of the sphere as seen by both eyes. These three pictures of the solids are all dissimilar. The right eye E does not see the part B I. C G A I F of the sphere; the left eye does not see the part B L C G A, while the part seen with both eyes is the hemisphere B L C G F, the dissimilar segments B F G, C G F being united in its vision.

FIG. 197.



After demonstrating his theorems on the vision of spheres with one and both eyes, Aguillonius informs us, before he proceeds to the vision of cylinders, that it is agreed upon that it is not merely true with the sphere, but also with the cylinder, the cone, and all bodies whatever, that the part which is seen is comprehended by tangent rays such as E B, E C for the right eye, in Fig. 197. "For," says he, "since these tangent lines are the outermost of all those which can be drawn to the proposed body from the same point, namely, that in which the eye is understood to be placed, it clearly follows that the part of the body which is seen must be contained by the rays touching it on all sides. For in this part no point can be found from which a right line cannot be drawn to the eye, by which the correct visible form is brought out."

Optical writers who lived after the time of Aguillonius seem to have considered the subject of binocular vision as exhausted in his admirable work. Gassendi, though he treats the subject very slightly, and without any figures, tells us that we see the left side of the nose with the left eye, and the right side of it with the right eye—two pictures sufficiently dissimilar. Andrew Tacquet, though he quotes Aguillonius and Gassendi on the subject of seeing distances with both eyes, says nothing on the binocular vision of solids; and Smith, Harris, and Porterfield only touch upon the subject incidentally. In commenting on the passage which we have already quoted from Leonardo da Vinci, Dr. Smith says, "Hence we have only one help to distinguish the place of a near object more accurately with both eyes than with one, inasmuch as we see it more detached from other objects beyond it, *and more of its own surface, especially if it be roundish.*" If any further evidence were required that Dr. Smith was acquainted with the dissimilarity of the images of a solid seen by each eye, it will be found in his experiment with a "long ruler placed between the eyebrows, and extended directly forward with its flat sides respecting the right hand and the left." "By directing the eyes to a remote object," he adds, "the *right side of the ruler seen by the right eye* will appear on the left hand, and *the left side on the right hand*, as represented in the figure."

In his treatise on *Optics* published in 1775 Mr. Harris, when speaking of the visible or apparent figures of objects, observes that "We have other helps for distinguishing *prominences of small parts* besides those by which we distinguish distances in general—as their degrees of light and shade, and *the prospect we have round them. And by the parallax, on account of the distance betwixt our eyes, we can distinguish besides the front part of the two sides of a near object not thicker than the said distance, and this gives a visible relievo to such objects which helps greatly to raise or detach them from the plane in which they lie. Thus the nose on a face is more remarkably raised by our seeing both sides of it at once.*" That is, *the relievo is produced by the combination of the two dissimilar pictures given by each eye.*

Without referring to a figure given by Dr. Porterfield, in which he actually gives drawings of an object as seen by each eye in binocular vision, the one exhibiting the object as seen endwise by the right eye, and the other the same object as seen laterally by the left eye, we may appeal to the experience of every optical, or even of every ordinary observer, in support of the fact, that the dissimilarity of the pictures in each eye,

by which we see solid objects, is known to those who have never read it in Galen, Baptista Porta, or Aguillonius. Who has not observed the fact mentioned by Gassendi and Harris, that his left eye sees only the left side of his nose, and his right eye the right side, two pictures sufficiently dissimilar. Who has not noticed, as well as Dr. Smith, that when they look at any thin, flat body, such as a thin book, they see both sides of it—*the left eye only the left side of it, and the right eye only the right side*, while the back, or the part nearest the face, is seen by each eye, and both the sides and the back by both the eyes? What student of perspective is there—master or pupil, male or female—who does not know, as certainly as he knows his alphabet, that the picture of a chair or table, or anything else, drawn from *one point of sight*, or as seen by one eye placed in that point is *necessarily dissimilar* to another drawing of the same object taken from another point of sight, or as seen by the other eye placed in a point of two and a half inches distant from the first? If such a person is to be found, we might then admit that the dissimilarity of the pictures in each eye was not known to every student of perspective.

Such was the state of our knowledge of binocular vision when two individuals, Mr. Wheatstone and Mr. Elliott, a teacher of mathematics in Edinburgh, were directing their attention to the subject. Mr Wheatstone communicated an important paper on the "Physiology of Vision" to the British Association at Newcastle in August, 1838, and exhibited an instrument called a stereoscope, by which he united the two dissimilar pictures of solid bodies, the τὰ στέρεα (*ta sterea* of Aguillonius), and thus reproduced, as it were, the bodies themselves. Mr. Wheatstone's paper on the subject, which had been previously read at the Royal Society on the 21st of June, was printed in their *Transactions* for 1838.

Mr. Elliott was led to the study of binocular vision in consequence of having written an essay, as early as 1823, for the class of logic in the University of Edinburgh, "On the Means by which We Obtain our Knowledge of Distances by the Eye." Ever since that date he was familiar with the idea that the relief of solid bodies seen by the eye was produced by the union of the dissimilar pictures of them in each eye, but he never imagined that this idea was his own, believing that it was known to every student of vision. Previous to or during the year 1834, he had resolved to construct an instrument for uniting two dissimilar pictures, or of constructing a stereoscope; but he delayed doing this till the year 1839, when he was requested to prepare an original communication for the Polytechnic Society, which had been recently established in Liverpool. He was thus induced to construct the instrument which he had projected, and he exhibited it to his friends, Mr. Richard Adie, optician, and Mr. George Hamilton, lecturer on chemistry in Liverpool, who bear testimony to its existence at that date. This simple stereoscope, without lenses or mirrors, consisted of a wooden box eighteen inches long, seven broad, and four and a half deep, and at the bottom of it, or rather its further end, was placed a slide containing two dissimilar pictures of a landscape as seen by each eye. Photography did not then exist, to enable Mr. Elliott to produce two views of the same scene, as seen by each eye, but he drew a transparency of a landscape with three distances. The *first* and most remote was the moon and the sky, and a stream of water from which the moon was reflected, the two moons being placed nearly at the distance of the two eyes, or two and a half inches, and the two reflected moons at the same distance. The *second* distance was marked by an old cross about a hundred feet off; and the *third* distance by the withered branch of a tree, thirty feet from the observer. In the right-hand picture, one arm of the cross just touched the disc of the moon, while, in the left one, it projected over one-third of the disc. The branch of the tree touched the outline of a distant hill in the one picture, but was "a full moon's breadth" from it on the other. When these dissimilar pictures were united by the eyes, a landscape, certainly a very imperfect one, was seen in relief, composed of three distances.

Owing, no doubt, to the difficulty of procuring good binocular pictures, Mr. Elliot did not see that his contrivance would be very popular, and therefore carried it no further. He had never heard of Mr. Wheatstone's stereoscope till he saw his paper on "Vision" reprinted in the *Philosophical Magazine* for March 1852, and having perused it, he was convinced not only that Mr. Wheat-

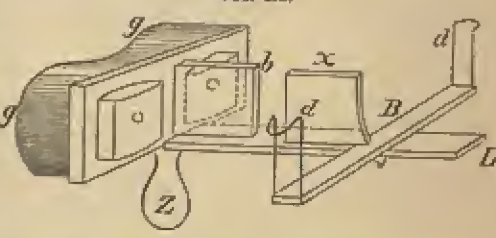
stone's theory of the instrument was incorrect, but that his claim to the discovery of the dissimilarity of the images in each eye had no foundation. He was, therefore, led to communicate to the same journal the fact of his having himself, thirteen years before, constructed and used a stereoscope, which was still in his possession. In making this claim, Mr. Elliott had no intention of depriving Mr. Wheatstone of the credit which was justly due to him; and as the claim has been publicly made, we have described the nature of it as a part of scientific history.

In Mr. Wheatstone's ingenious paper of 1838, the subject of binocular vision is treated at considerable length. He gives an account of the opinions of previous writers, referring repeatedly to the works of Aguillonius, Gassendi, and Baptista Porta, in the last of which the views of Galen are given and explained. In citing the passage which we have already quoted from Leonardo da Vinci, and inserting the figure which illustrates it, he maintains that Leonardo da Vinci was not aware "that the object (c in Fig. 196) presented a different appearance to each eye." "*He failed*," he adds, "*to observe this, and no subsequent writer, to my knowledge, has supplied the omission. The projection of two obviously dissimilar pictures on the two retinæ, when a single object is viewed, while the optic axes converge, must therefore be regarded as a new fact in the theory of vision.*" Now, although Leonardo da Vinci does not state in so many words that he was aware of the dissimilarity of the two pictures, the fact is obvious in his own figure, and he was not led by his subject to state the fact at all. But even if the fact had not stared him in the face he must have known it from the optics of Euclid and the writings of Galen, with which he could not fail to have been well acquainted. That the dissimilarity of the two pictures is *not a new fact* we have already placed beyond a doubt. The fact is expressed in words, and delineated in drawings, by Aguillonius and Baptista Porta. It was obviously known to Dr. Smith, Mr. Harris, Dr. Porterfield, and Mr. Elliott, before it was known to Mr. Wheatstone, and we cannot understand how he failed to observe it in works which he has so often quoted, and in which he professes to have searched for it.

This remarkable property of binocular vision being thus clearly established by preceding writers, and admitted by himself, as the cause of the vision of solidity or distance, Mr. Wheatstone, as Mr. Elliott had done before him, thought of an instrument for uniting the two dissimilar pictures optically, so as to produce the same result that is obtained by the convergence of the optical axes. Mr. Elliott thought of doing this by the eyes alone; but Mr. Wheatstone adopted a much better method of doing it by reflection. He was thus led to construct an apparatus, to be afterward described, consisting of two plane mirrors, placed at an angle of 90°, to which he gave the name of *stereoscope*, anticipating Mr. Elliot both in the construction and publication of his invention, but not in the general conception of a stereoscope.—*Sir David Brewster.*

(See *Binocular Vision, Monocular Vision, Stereoscopic Angle, Stereoscopic Camera, Double Reflecting Stereoscope, Eye-glass Stereoscope, Lenticular Stereoscope, Microscope Stereoscope, Opera-glass Stereoscope, Reading-glass Stereoscope, Reflecting Stereoscope, Prism Stereoscope, Total Reflexion Stereoscope, Stereoscopic*, etc., for descriptions of the various stereoscopes once in use, and to the methods of making stereographs, and the theory of stereoscopic views.)

FIG. 198.



2. *Stereoscope.* An optical instrument which serves to unite two flat perspective pictures of the same object, taken at the same distance and in the same horizontal plane but from two slightly separated standpoints, into one picture, appearing as a body. Some are held in the hand, and some are made to revolve in a case.

Thus Fig. 198 illustrates the old "Holmes 'Scope." *B* is a slide on which the picture is placed, with the wires *d d* at the ends, the whole sliding on *L*. *Z* is the handle, *g g* the

hood, *o o* the lenses, and *b x* the division between the lenses.

The early history of the stereoscope has been given above. The instrument was popularized by the invention of Dr. Oliver Wendell Holmes, about 1864, and further improved by Joseph L. Bates. The engravings below illustrate their invention, which is too well known to require further explanation.

FIG. 199.

Stereoscope, Panoramic. (See *Panoramic Stereoscope.*)

Stereoscopic. Possessing the property of producing relief in the stereoscope; pertaining to the stereoscope; giving stereoscopic effect.

Stereoscopic Ambrotype. This is a novel method of sealing ambrotypes, which gives them a stereoscopic effect. The ambrotype is first taken with a dark background instead of the usual white one. After it is dried, a small camel's-hair brush is used to apply the black varnish to the reverse side of the glass, and only enough to cover the figure, allowing the background to remain perfectly clear and transparent. Place a piece of Bristol board on the back of the glass, and the picture will be seen to stand out in bold relief. All positives on glass sealed with the collodion side uppermost require an extra glass over them for protection. By using a third glass instead of the Bristol board, a beautiful effect is produced, if the glass is coated with collodion and exposed in the camera to the white background, and developed and fixed exactly as in the process of taking the portrait. Any desired shade can be obtained, and a great variety of colors may be used, instead of white, the effect of which is very pleasing.

Stereoscopic Angle. The angle at which stereographs are taken in order to produce the effect of relief in the stereoscope. Considerable controversy has been held upon the proper angle at which the camera should be placed to get the stereoscopic effect true to Nature, and to binocular vision; but it is now generally conceded that two and a half inches apart is the proper distance in all cases, at which to place the lenses, and all stereoscopic cameras are now constructed on that principle. It has been argued that in taking a distant bird's-eye view of a town, the effect is more "stereoscopic" by removthe cameras some yards apart, the artist at the same time avoiding very near objects. He thus gets a portion of the town upon his plate and all "*nicely stereoscopic*;" this is quite correct. It is certainly very pleasing to behold; but never has a pair of human eyes seen this town as the stereoscope will show his two pictures taken at such an angle. The result of separating the cameras so widely apart is, to reduce the town to a "model" of so many inches to a mile. For instance, did he possess a true model of this town and take stereographs of it, by moving the camera 2½ inches he would in the latter case have similar pictures to the former, that is, stereographs of the *model* of the town, and not stereographs of the *town*. This is why so many of the French pictures appear so like cardboard models. Every house, chimney, etc., appear more distinct than in Nature, the fore- and backgrounds are seen with the same minuteness of detail, just as we see when looking at a model where *all* its parts range but a few feet from the eyes. When viewing a model the eyes are comparatively some yards apart; consequently a model can never, in perspective, be true to Nature. In removing the camera more than 2½ inches you alter the relative position of the objects, as they are not in the natural line of vision. Objects in the background that would not be observed by those in the foreground at the natural distance of the eyes, would be wholly or partially exposed. In fact there would be a complete derangement in the relative appearance of everything in the field of vision. This certainly could not be as we see Nature. It is thus evident that this instructive instrument may be made *too* interesting by pandering to the common taste, to the sacrifice of true science. Again, in taking a large monumental group, the artist may think that

here, as he has no fore- or background objects to attend to, he may move the camera to any reasonable distance, so as to give a bold relief to all parts. To reduce this monument to within the size for stereographs, he may have to place the camera, say fifty yards off; he then, for the second picture, moves the camera perhaps three or four yards. He will again produce a very nice stereoscopic picture, but not a correct copy of the monument, it will be the copy of a similar monument, but of a *much smaller size*. In looking at that monument with the two eyes, separated as they are, 2½ inches apart, its several parts will occupy certain positions relative to each other. Look at a small model of this same monument, and the *relative positions* of its several parts will not appear the same, being viewed under a greater binocular angle. The mind consequently becomes conscious that it is in the one case taking cognizance of a large monument, and in the other of a very small one, or a model of the same. To remove, therefore, the camera to a greater angle than the eyes, will convey to the brain the sense of *diminution* in the size of the object or objects drawn; and if the angle is still increased, it will then have the effect as if you had brought the object close up to the eyes. To make a man's arm, leg, or nose appear unnaturally extended beyond their usual length: Take a man in a sitting posture with the body slightly bent forward, by a pair of stereoscopic lenses placed 2½ inches apart, and then take a second with two cameras placed 2½ feet apart; in viewing them in the stereoscope, the first will give the relative positions of every part of the figure, true to Nature, while the second position will become distorted under the eye, the head and knees will gradually approach the eyes, and the posterior parts of the body will recede, until the head and knees will appear to touch your eyes, while the posteriors and feet (if they be drawn in toward the chair) will seem miles away. We want no better illustration of what constitutes the *true stereoscopic angle* than two such pictures.

Stereoscopic Camera. One of the forms in use for making binocular views is shown in Fig. 200. *A*, the camera; *B*, the ground-glass; *C*, the catch for retaining *B* in place; *D*, the body of the camera; *E*, the swing-back; *F*, the slide; *G*, the track on which the camera moves. The stereoscopic camera must be provided with two objectives of equal foci, for taking two impressions, side by side, of the same object at the same time on one

Fig. 200.

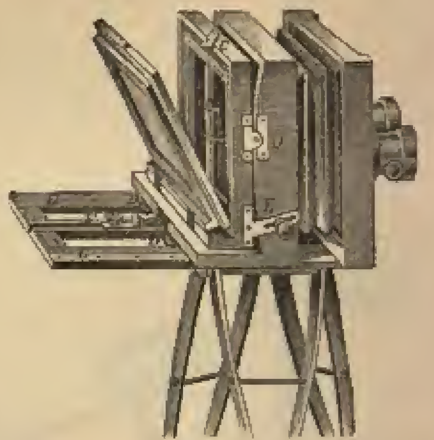
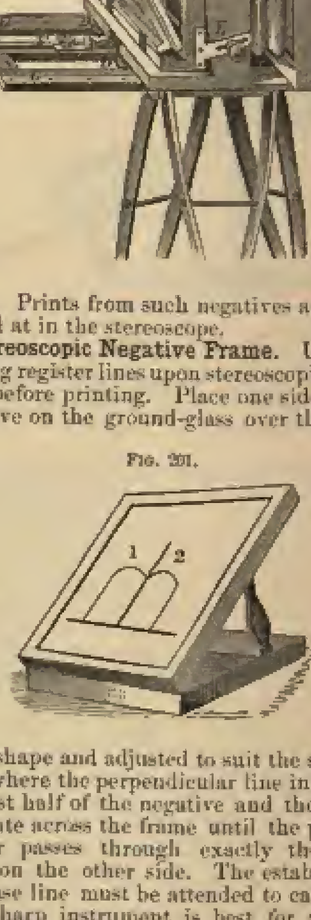


plate. Prints from such negatives are to be looked at in the stereoscope.

Stereoscopic Negative Frame. Used for placing register lines upon stereoscopic negatives before printing. Place one side of the negative on the ground-glass over the indi-

Fig. 201.



cated shape and adjusted to suit the subject. Note where the perpendicular line intersects the first half of the negative and then slide the plate across the frame until the perpendicular passes through exactly the same point on the other side. The establishing of a base line must be attended to carefully. Any sharp instrument is best for making lines. After having arranged the negative over the shape, paste a strip of yellow paper along the edge that is marked No. 2. After

having moved the negative across the retouching stand and placing it as directed, that is with the perpendicular pencil line on the ground-glass showing through exactly the same point of the subject, paste another strip of paper along the edge only. You now have the negative with the line at the bottom across its entire length and with a guide at each side. The print will show a black base-line and white perpendicular at each end of the strip.

Stereoscopic Panopticon. A combination of the philosophical toy called the panopticon, or magic circle, with the stereoscope. By a very simple arrangement, a succession of figures, varying slightly from one another, are made to appear as one figure in motion, or in the performance of some regularly recurring action. There are various photographic ways in which the combination could be effected, but the following will be found the most convenient. In the first place, the photographic artist having decided upon the scene or action, or group of actions, he wishes to represent, and having made arrangements with a person or number of persons for this purpose, would require to have them so instructed that they would allow him to take stereoscopic views of a scene at a number of—say eight or ten—different stages of its progress; that is to say, one entire performance of the action or scene should be interrupted by eight or ten arrests or stops for such periods of time as would allow of as many stereoscopic representations being taken. The positives of these views, instead of being fitted up in the usual manner, would require to be pasted on a sheet of cardboard one underneath the other in their consecutive order. By means of a penknife and ruler, a cut should next be made between each of the pairs of views, in order to cut half through the card, so as to allow of its being bent at those lines, and thus closely applied to the surface of a diagonal or ten-sided drum, upon which any number of such sets of views could be attached seriatim if required. The drum or cylinder with a set of views thus attached to it, should then be placed in its position, by fitting the two extremities of its axis into sockets on the stereoscope adapted to receive them. To a person now looking into the instrument, there would be presented ten stereoscopic views slightly differing from each other according as each successive picture was brought into the field of view by the revolution of the drum. But to produce the magical illusion of their being but one group, and that in active and life-like motion, a small addition to the apparatus will be necessary, namely, a shade or diaphragm to each of the eye-glasses, by means of which they can be be covered and uncovered in harmony with the motion of the drum. This is effected by attaching an elbow lever to the crank of the drum and to the diaphragm in such a manner as to cause the shades to cover the eye-glasses except at the moment when each successive picture is brought into the field of view, except at the moment when it is at right angles to the axes of vision. The proper way to use the instrument would be, in the first place, to look intently at the scene with the first of the series of figures in position, so as to get a thoroughly stereoscopic view of it, and then to commence turning the handle at such a speed as to produce the most artistic pantomimic effect.

Stereoscopic Printing. In printing stereograms the same manipulations and sensitizing, toning and fixing solutions may be employed as for single photographic pictures; but it is necessary to cut the two pictures apart after printing and transpose them, as they are reversed in the binocular camera. Another way, however, is to cut the negative in two through the centre between the pictures and transpose them before printing. They can thus be preserved in their proper positions by fastening them to a plate of glass, collodion side outward, with strips of gum-paper. In this way three or four pairs of negatives may be attached to an 8 x 10 glass and printed at the same time, avoiding the use of a number of pressure-frames. (See Index and *Printing*.)

Stereoscopic Slides. Stereographs are sometimes termed stereoscopic slides.

Stereoscopic Thaumatrope. An apparatus invented by Mr. P. H. Desoignes for exhibiting photographic, stereoscopic, and other pictures, models, figures, and designs. The object of the invention is to show in one apparatus a series of stereoscopic or other representations or models taken by different lenses, as if the scene or things represented were in motion. The apparatus is cylindrical, and the cylinders are caused to rotate either vertically or horizontally. To exhibit stereoscopic views the inventor takes a cylinder and sets it vertically. In the interior, in

suitable frames provided for the purpose, he places, say six, but there may be more or less stereoscopic slides; the periphery of the cylinder has formed across it as many slots as there are sets of slides. One or more glasses for viewing the pictures are supported and held stationary outside the periphery of the cylinder, or may be otherwise placed. The views may represent, for instance, a steam engine, and each view must be taken when the engine is at different parts of its stroke. The views being placed in the cylinder, and the cylinder being caused to rotate, will show to the eye the steam engine as if in actual motion. For exhibiting some models and drawings he arranges them around a horizontal cylinder. Vertical slots are made in the periphery, through which to see the models or drawings.

Stereoscopic Transparencies. Stereograms on glass to be viewed by transmitted light.

Stereotrope. The name given to Mr. Shaw's stereoscopic thaumatrope. This instrument is an application of the principle of the stereoscope to the thaumatrope, which depends for its results on the "persistence of vision," and somewhat resembles the Stereoscopic Panopticon; or rather, it may be termed an improvement on the latter. The following is Mr. Shaw's description of the manner in which he adapts the refracting form of the stereoscope to this purpose.

Having procured eight stereoscopic pictures of an object—of a steam engine, for example—in the successive positions it assumes in completing a revolution, I affix them in the order in which they were taken, to an octagonal drum which revolves on a horizontal axis beneath an ordinary lenticular stereoscope, and bring them one after another into view. Immediately beneath the lenses and with its axis situated half an inch from the plane of sight, is fixed a solid cylinder, four inches in diameter, capable of being moved freely on its axis. This cylinder, which is called the eye-cylinder, is pierced throughout its entire length (if we except a diaphragm in the centre inserted for obvious reason) by two apertures, of such a shape, and so situated relatively to each other that a transverse section of the cylinder shows them as cones, with their apices pointing in opposite directions, and with their axes parallel to, and distant half an inch from, the diameter of the cylinder. Attached to the axis of the eye-cylinder is a pulley, exactly one-fourth the size of a similar pulley affixed to the axis of the picture-drum, with which it is connected by means of an endless band. The eye-cylinder thus making four revolutions to one of the picture-drum, it is evident that the axes of its apertures will respectively coincide with the plane of sight four times in one complete revolution of the instrument, and that, consequently, vision will be permitted eight times, or once for each picture. The cylinder is so placed that at the time of vision the *large* ends of the aperture are next the eyes, the effect of which is that when the *small* ends pass the eyes, the axes of the apertures, by reason of their eccentricity, do not coincide with the plane of sight, and vision is therefore impossible. If, however, the position of the cylinder be reversed, end for end, vision will be possible only when the small ends are next the eyes, and the angle of the aperture will be found to subtend exactly the pencil of rays coming from a picture which is so placed as to be bisected at right angles by the plane of sight. Hence it follows that the former arrangement of the cylinder being reverted to, the observer looking through the upper side of the aperture will see a narrow strip extending along the top of the picture; then moving the cylinder on and looking along the lower side of the aperture, he will see a similar strip at the bottom of the picture; consequently in the intermediate positions of the aperture the other parts of the picture will have been projected upon the retinæ. The width of these strips is determined by that of the small ends of the apertures, which measure 0.125 inch, and the diameter of the large ends is 1.5 inch, the lenses being distant nine inches from the pictures. The picture-drum being caused to revolve with the requisite rapidity, the observer will see the steam engine constantly before him, its position remaining unchanged in respect to space, but its parts will appear to be in motion and in solid relief, as in the veritable object. The stationary appearance of the pictures, notwithstanding their being in rapid motion, is brought about by causing their corresponding parts to be seen respectively, *only* in the same part of space, and *that* for so short a time that while in view they make no sensible progression. As, however, there is an actual progression during the instant of

vision, it is needful to take that fact into account—in order that it may be reduced as far as praticable—in regulating the diameter of the eye-cylinder, and of the apertures at their small ends; and the following are the numerical data involved in the construction of an instrument with the relative proportions given above:

The circumference of picture-drum = 22.5 inches (A).

The circumference of eye-cylinder = 12 inches × 4 revolutions = 48 inches (B).

The diameter of apertures at large ends = 1.5 inch (C).

The diameter of apertures at small ends = 0.125 inch (D).

While the large end is passing the eye, the picture under view progresses:

$\frac{1.5\ (C)}{48\ (B)}$ of 22.5 (A), or 0.703 inch.

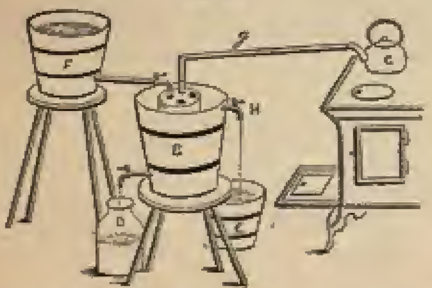
This amount of progression (0.703 inch) if perceived at one and the same instant, would be utterly destructive of all distinctness of definition; but it is evident that the total movement brought under visual observation at any one moment is

$\frac{0.125\ (D)}{1.5\ (C)}$ of 0.703 inch, or 0.058 inch.

This movement must necessarily occasion a corresponding slurring, so to speak, of the images on the retinæ, and the fact of such slurring not affecting, to any appreciable extent, the distinctness of definition, seems to be referable to a faculty which the mind has of correcting or disregarding certain discrepant appearances or irregularities in the organ of vision.

Sticking-Paper. (See *Sealing-Paper.*)

FIG. 202.

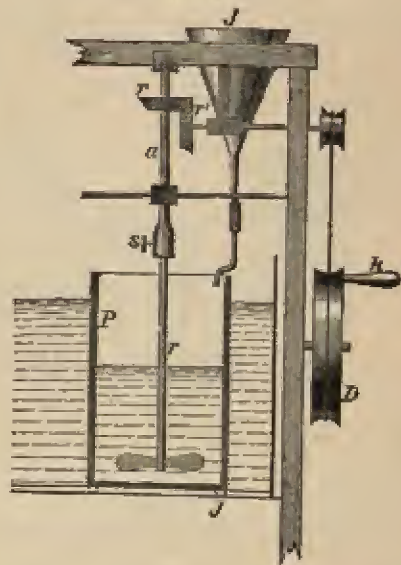


Still. Used for distilling water. Fig. 202 shows condenser perforated with water-flues; B, tank in which the condenser is immersed; C the generator; *g* the steam-pipe; D the receiver of distilled water, and F the supply cistern of cold water, which should be so placed that the water will fall upon the top of the condenser. E is the hot-water waste which escapes from the tank at a spigot, H.

Stipple. To secure the reproduction of half-tone in the photo-mechanical processes, it is necessary to produce upon the block used in printing a fine grain or stipple. These may be obtained by reticulation of the film of gelatine in the collotype process; by means of powders dusted on the surface of copper or steel plates in the intaglio processes; or by the use of a network screen, as in the half-tone photo-engraving processes. A complete summary of all the known methods of producing grain in photo-mechanical work was given in *Wilson's Photographic Magazine*, vol. xxx.

Stirring Apparatus for Emulsion. This consists of a hard rubber stirrer, *r*, dipping

FIG. 203.



into the solution in the jar, *P*, and turning on a vertical axis supplied with a bevelled wheel *r r'*. The axle of the latter is connected with a multiple wheel and handle,

D k. For preparing large quantities of emulsion steam heating is recommended. If placed over a fire the jar should rest on iron supports so that hot water can circulate under the bottom.

Stock Solutions. Solutions that keep for a long time ready for use, and so may be prepared in large quantities.

Stop. A diaphragm, the use of which is to correct, in a measure, the spherical aberration of a lens, and to increase the sharpness of the image upon the ground-glass and sensitive surface. A great consideration in testing a lens is the size of the stop, and few are aware of the vast influence this has upon the time of exposure required in taking a photograph, yet it can easily be calculated by simply comparing the squares of the diameters of the various stops to be used, and the time will be in inverse proportion. Thus it will be found that an inch stop is sixteen times larger than a quarter-inch stop, and consequently sixteen times quicker. The immense advantage of large stops cannot therefore be overrated; but unfortunately the lenses now manufactured to give correct and fine definition with large stops are generally very deficient in "depth of focus;" and rapidity of action without that is a delusion. It is usually the practice to place all the stops in the same position, but it frequently happens in practice that a change of position is necessary, owing to a deficiency of light or the necessity for very rapid action; it is essential that all the stops should be properly placed to produce an image of equal illumination and comparative sharpness over all the field, and this is impossible with all the stops in one position. The longer the focus of the lens the larger the stop may be. Nothing is more illustrative of this fact than the comparison of solid lead pencils of different diameters; for the thicker pencil must be sharpened to a longer point (or focus) to produce as fine a stroke as the smaller one. These "pencils of lead" likewise will fully indicate the pencils of light through stops of proportionate sizes, and explain the argument relating to their positions, the refraction of light by the lens not affecting the conditions, because the stops have no material influence upon such refraction. (See *Diaphragm*.)

Stop Down, or Diaphragming. To reduce the opening of an objective by inserting a diaphragm. This is done to correct the spherical aberration, that is the blur showing on the edges of the optical picture more or less. The smaller the opening the more extended the sharp field, but at a corresponding loss of active light.

Stoppers. The glass stoppers used with bottles containing deliquescent substances often become tightly fixed and are difficult to remove. The best way to remove such stoppers depends upon the cause of their being fast. Sometimes a little warm water will be sufficient, or a drop or two of oil, or the stopper may be held in a wood-vice, when a turn or two will loosen it from the bottle.

Strain (of the Lens). A lens is strained by moving the front board, which holds the lens, or by the upward pointing of the whole camera, thus greatly altering the relative positions of lens and ground-glass, which latter, in such cases, has to be tipped in the opposite direction. In this way a lens is tried to its utmost as concerns illumination and sharpness. A very small diaphragm in such cases helps matters greatly.

Streaks. Imperfections frequently occurring in collodion and other pictures from various causes. (See *Imperfections in Negatives and Positives*.)

Strengthening the Negative. (See *Intensifying the Negative; Re-development*, etc.)

Stripping Film. This consists of a layer of insoluble gelatine coated with a sensitive emulsion, which is attached to a paper support by a second layer of soluble gelatine. The manipulation of such films, which are a great convenience for many photographic purposes, are treated precisely as gelatine plates are treated; and after development and clearing are laid down upon a collodionized glass, squeezed into optical contact, placed in hot water and stripped. To strip ordinary gelatine films from glass plates, see *Reversed Negatives;* or the following method may be used:

The plate is first coated with a collodion giving a tough and horny film; as soon as the latter is completely set it is immersed in the following mixture:

Hydrofluoric Acid	1 part.
Water	10 parts.
Alcohol	10 "

In a few minutes the film shows signs of rising at the edges, and one corner is seized with tweezers, turned back, and the whole

cautiously and slowly drawn off, care being taken to keep it entirely beneath the surface of the liquid. The acid solution is then poured off, replaced by water to which a few drops of ammonia have been added, and this latter by plain water. The film is then either dried as a separate film or mounted in a reversed position on glass in the usual way.

Structureless. That condition of the collodion film which causes it to spread smooth and glassy upon the plate and to adhere firmly, exhibiting no tendency to contract and separate from the sides. (See *Collodion*, etc.)

Studio. A sectional view (Fig. 204) of a well-contrived studio is given for the guidance of those who may wish to construct for themselves. The description is as follows: A is an exhibition room on the ground-floor; B is a sitting-room; C and D are artists' rooms; E, ladies' dressing-room; F, hall; G, stairs to operating-room; H, framing-room; K K, operating-room; L, chemical room; M, photographic printing room; N N N, three dark-rooms; P, gentlemen's dressing-room; R, stock-room; S S, offices; V, skylight over artists' room; W, large skylight for operating-room, 25 feet wide by 16 long, with two side-lights extending from floor to ceiling, enabling the artists to take pictures in any kind of weather. The walls outside near the skylight, and inside, are painted gray or blue, giving a soft, mellow tone to the light.

FIG. 204.

Subchloride. Containing one equivalent less chlorine than a chloride.

Subchloride of Silver. Violet argentic chloride of silver. Ag_4Cl_3; also Ag_2Cl. A substance formed by the action of light on the chloride of silver, or by chlorides on silver. Of brown-violet color; insoluble in water and acids. In the solar spectrum it takes on the different colors, and has been used on that account in heliochromy.

Subdued. Applied to light this word means softened or mellowed—depriving it of its full force or intensity; applied to the daguerrotype or photograph, it means softened, not over rigorous, or harsh.

Sublimate, Corrosive. (See *Corrosive Sublimate* and *Sulphuretted Paper*.)

Sublimation. The operation of bringing a solid substance into the state of vapor by heat and condensing it again into a solid by cold. Sublimation bears the same relation to a solid that distillation does to liquid. Both processes purify the substances to which they are severally applied, by freeing them from the fixed and grosser matters with which they are cemented.

Sublimating. Subliming, to evaporate a solid body by heat and again condense into a solid (sublimate) in another place by cooling. Applied for separating different substances, and for purifying volatile bodies—for instance, iodine.

Subnitrate of Bismuth. The subnitrate of bismuth is prepared by pouring into a large quantity of water a solution of the nitrate of bismuth; decomposition takes place, a white bulky powder falls down, and a binitrate of bismuth remains in solution. In this case 3 equivalents of the nitrate suffer decomposition, 2 equivalents of the oxide and 1 of the acid unite and subside, whilst 2 of the acid and 1 of the oxide remain in solution.

Suboxides. When a compound of oxygen with a metal contains less than one equivalent of the former to one of the latter, it is called a suboxide.

Suboxide of Silver. This substance is obtained on exposing a solution of ammonio-nitrate of silver to the action of the air. It bears to the ordinary brown protoxide of silver a similar relation to that which the subchloride bears to the protochloride of silver.

Substances, Acid. Acids color blue litmus-paper red, and combine with alkalies and other bases, causing mutual neutralization. Acids are either oxygen or hydrogen combinations, the former consisting of a metalloid (rarely of a heavy metal) and oxygen, the latter being chiefly combinations of halogens (chlorine, bromine, iodine, and fluorine) with hydrogen.

Substitution. To transform the metallic portion of a photographic picture into another metal by treatment with certain solutions, for instance a silver print into a gray-black platinum picture, by toning in a platinum bath.

Substratum. A thin layer of albumen, gelatine, or rubber flowed upon glass or paper to insure the adhesion of the sensitive film in photography.

Subterranean Photography. Mr. Langlois has constructed an apparatus for subterranean photography in cases where the only means of communication to underground localities is a narrow shaft, and the instrument must be manipulated from the surface. His invention consists of a *camera obscura* of small size, the plate being about 2 inches square, and the focus of the lens being of comparatively short range. The camera, mounted in a metallic case or tube, open on one side, can be lowered by means of a cord or small chain attached to the tube. The camera is pivoted within the tube at its upper end, so that it can be kept at any angle by means of a cord or small chain fastened to the lower end of the camera. Above and below the camera are placed rows of incandescent lamps. When the apparatus is lowered and the camera made to incline outward from the case, the current is turned on and the plate exposed. The photographs thus obtained are said to be excellent. A large engraving and full description appeared in *The Philadelphia Photographer*, vol. xxiii. page 660.

Succinate. A compound formed by the union of succinic acid with a base.

Succinate of Ammonia. A very soluble salt in water, obtained by neutralizing succinic acid with ammonia.

Succinic Acid. Procured from amber by heating the powdered amber in a retort and collecting the acid which comes over, adding nitric acid and re-distilling. It crystallizes in white transparent crystals, soluble in 96 parts cold, and 2 parts boiling water. Boiling alcohol takes up half its weight. It is also soluble in nitric and sulphuric acids; muriatic acid converts it into a gelatinous substance. This acid is used in the production of energiatype pictures. (See *Energiatype.*)

Sugar Dry Process. A preservative process in which sugar is used for keeping the collodion in a sensitive state for an indefinite length of time. The manipulations of this process are the same as for any other preservative process.

Sugar of Milk. Sugar of milk is produced by concentrating, by heat, the whey which is obtained in the manufacture of cheese. The liquid cooled and left to itself deposits upon the walls of the vessels which contain it very hard crystals, which are in thick layers. This salt is most extensively manufactured in Switzerland. Sugar of milk is employed in various modifications of the photographic process. It is used in the following manner: Boil 80 ounces of rice in a porcelain or earthen vessel containing 4½ pints of distilled water. The rice must be only slightly swollen, in order that the liquid obtained may not be too pasty from an excess of starch, but contain only the glutinous part of rice. Then strain the whole through a fine linen cloth. This is an excellent sizing which gives body to the paper, and very fine darks. To prepare the first bath in which the paper is to be soaked for the purpose of receiving the salts which must form the sensitive preparation through reaction of the aceto-nitrate of silver, you dissolve in 1¼ pints of rice-water, such as just described, the following substances:

Sugar of Milk	154	grains.
Iodide of Potassium	231	"
Fluoride	7¾	"
Cyanide	12¾	"

When the whole is perfectly dissolved, filter through fine linen, and receive the liquid into a bottle, to be kept for use. This preparation may be preserved a very long time without suffering any change, and used until it is exhausted. When you wish to prepare the paper, pour this solution into a large dish, and put in your paper leaf by

leaf, one upon another, taking care to disperse any air-bubbles which may be formed and adhere to the paper. Put in in this manner 15 or 20 leaves at a time into the dish, and let them soak from half an hour to an hour, according to the thickness of the paper. Then turn the whole, those at the top to the bottom, and beginning with the first leaf immersed, take them out one by one and hang them up by one corner to dry. When hung up, attach to the opposite corner—where the liquid gravitates—a piece of bibulous paper, which attracts the liquid, and facilitates the drying process. Be careful never to mix together the English and French paper in the same basin, but prepare them separately. The English paper contains a free acid, which occasions the immediate precipitation of an iodide of starch in the French paper, and completely tints it of a deep violet color. The paper being dry, cut it to the size of your camera, and preserve it in a portfolio for use. As this paper is almost entirely insensible to light, it may be made in the daytime. However, a very long exposure to vivid light would decompose the iodide of potassium in the starch of the paper. It is advisable to guard against a very bright light. This paper may answer without distinction for landscapes and portraits. It admits of great modulation of tones and of very intense darks. It is, however, less quick, if it has not been waxed like the paper which is all described in another part of this work, and which is exclusively designed for portraits; but if it is waxed and dry it competes with it in rapidity. The liquid which remains after withdrawing the paper is poured into a stoppered bottle and used, as was remarked, with new preparations until exhausted. It is sufficient merely to re-filter it at the time of using. We can also—especially when making use of paper previously waxed—add to the solution the viscous residue of two whites of eggs beaten into foam, to each 1½ pints of the preparation. (See *Collodion.*)

Sulphate. A saline compound of sulphuric acid with a base.

Sulphate of Copper. Cupric sulphate, blue vitriol. $CuSO_4+5H_2O$. Blue crystals, soluble in 2 volumes of cold water, insoluble in alcohol. Mixed with solution of sulphate of iron, it retards the oxidation of the latter.

Sulphate of Iron and Ammonium. Ammonio-sulphate of iron, ammonio-ferrous alum. $FeSo_4+(NH_4)_2SO_4+6H_2O$. Bluish-green crystals, more stable in the air than sulphate of iron. Used, like the latter, as a developer.

Sulphate of Iron. Protosulphate of iron, ferrous sulphate. $FeSO_4+7H_2O$. Bluish-green crystals, which decompose in air; soluble in water, insoluble in alcohol. Used in iron developer.

Sulphate of Quinine. (See *Quinine.*)

Sulphate of Silver. This salt may be prepared either by boiling metallic silver in sulphuric acid, or by adding to a solution of nitrate of silver a solution of the sulphate of soda. In the first case one portion of the sulphuric acid is decomposed, giving to the silver an equivalent of oxygen, and giving off sulphurous acid gas; the oxide of silver thus formed unites with the sulphuric acid and sulphate of silver is the result. In the second instance the product is the consequence of double decomposition.

Sulphate of Zinc. This salt is prepared by pouring very dilute sulphuric acid upon metallic zinc; a brisk action ensues and a large quantity of hydrogen gas escapes, demonstrating the decomposition of water, the oxygen of which unites with the metal and then combines with acid, forming the salt, which is obtained in the crystalline state by evaporation.

Sulphide of Ammonium. Ammonium sulphide, sulphuret of ammonia. $(NH_4)_2S$. Colorless liquid, smelling of rotten eggs, and becoming first yellow, then brown in the air. Used to blacken negatives, bleached with bichloride of mercury.

Sulphide of Antimony. Antimony sulphide. Sb_2S_3. Black powder, resembling graphite. Used in the preparation of flash-light mixtures for exposures by artificial light, in which case it is mixed with sulphur, chlorate of potash, and magnesium powder.

Sulphide of Mercury. This compound is the most abundant of the ores of mercury, and as a mineral product is termed *cinnabar;* but when prepared artificially it constitutes the beautiful red pigment known as vermilion. It is prepared by subliming 1 part of flowers of sulphur with 6 of mercury; the product is a blackish-red crystalline mass, which by friction and pulverization assumes a fine scarlet color.

Sulphide of Mercury Printing Process. This process, the discovery of Messrs. Salmon & Gariner, of France, consists in apply-

ing to paper a solution of sulphur, either in chloroform or sulphide of carbon; exposing it to sunshine under a negative for one minute and developing the image either with a dabber of cotton charged with lamp-black, or by exposing the print to the vapor of mercury. In the former lamp-black and in the latter mercury adheres to those parts only which have been affected by light. The print is then to be immediately varnished with gum or albumen. The sulphide of mercury forms a dark-brown substance in the shadows, which is so far permanent that it resists the action of alcohol, ammonia, and sulphuric, nitric, and hydrochloric acids of ordinary strength, also of cyanides, organic acids, and alkaline sulphides.

Sulphide of Potash. Potassium trisulphide, liver of sulphur. K_2S_3. Liver-colored amorphous mass, very soluble in water. Used for reducing black sulphide of silver from old fixing baths.

Sulphide of Silver. Sulphuret of silver. Ag_2S. Is precipitated from solutions of oxide of silver salts by sulphuretted hydrogen. Often deposits itself on the sides of dishes containing fixing-baths rich in silver salt, is difficult of solution in water, causes sulphur tones in chloride of silver prints, which it gradually fades if allowed to remain in them.

Sulphite. A salt formed by the union of sulphurous acid with a base. Frequently used by paper-makers for bleaching paper. The presence of this salt is detrimental to the formation of good photographs, creating black spots by the formation of sulphate of silver.

Sulphite of Ammonium. $(NH_4)_2SO_3$. Formerly used as preservative in pyro-ammonia developer.

Sulphite of Soda. Na_2SO_3. Prismatic, colorless crystals, becoming, by oxidation and loss of water in the air, dim and lustreless. Reacts alkaline; dissolves in 4 volumes of cold and ½ volume of hot water. Used as a preservative in alkaline developers and for blackening negatives bleached by bichloride of mercury in the intensifying process.

Sulphocyanide of Ammonium. Ammonium sulphocyanate. $(NH_4)CNS$. Colorless, deliquescent salt, soluble in water and alcohol. Used in the toning-bath, especially for chloride of silver gelatine papers.

Sulphocyanide of Potash. Potassium thiocyanate. KCNS. Colorless crystals, very soluble in water and alcohol. Used in certain combined toning and fixing baths. Is very poisonous.

Sulpho-Pyrogallol Developer. About 1880, Berkeley suggested the use of sodium sulphite in the pyro developer, as a preservative, and also as giving effects in the negative otherwise unobtainable. To the developer introduced by Mr. Berkeley the name of sulpho-pyrogallol was given. The addition of sulphite to the developer has since become common. One of the formulæ originally given by Mr. Berkeley is as follows:

Pyro	10 parts.
Sodium Sulphite	40 "
Water	25 "

Citric Acid sufficient to turn blue litmus red.

In recent years acid sulphite has been recommended as a substitute for the sodium sulphite and citric acid. Meta-bisulphite of potassium is also successfully used in this way.

Sulphur. A yellow, brittle, body, solid or firm at usual temperature; very combustible; insoluble in water; soluble in bisulphuret of carbon, chloroform, and sulphurchloride. Sulphur-milk is sulphur precipitated from alkaline solutions by an acid.

Sulphuretted Hydrogen. Hydro-sulphuric acid. H_2S. At usual temperature a gas; it becomes liquid under a pressure of 17 atmospheres, and solidifies at a temperature of —86° C. Precipitates silver, gold, and all other heavy metals from their solutions; dissolves gold when combined with potash or soda, forming a double sulphide of gold and potash or soda respectively.

Sulphuric Acid. H_2SO_4. Colorless, oily, hygroscopic, very sour-tasting liquid. Non-fuming sulphuric acid is of English make; the fuming sulphuric acid is Nordhausen sulphuric acid. Used in the preparation of pyroxylin, in the formulæ of several developers, for cleaning plates, etc.

Sulphuric Ether. This substance is prepared by mixing together in a retort equal parts by weight of sulphuric acid and alcohol and exposing them to the action of heat. The alcohol should be poured in first and the acid added by degrees by means of a funnel, and then immediately put upon a sand-bath heated to 200°; a receiver must be attached and kept very cold with ice. The distillation must be continued till as much fluid passes over as is equal to half the

alcohol employed and then a fresh supply of alcohol (half the original quantity) must be added and the distillation carried on. It must then be agitated in water and potash, and the alkali separated by a second distillation to render it pure. (See *Ether*.)

Sulphuret of Ammonia. (See *Hydrosulphuret of Ammonia*.)

Sulphuret of Mercury. This compound is prepared by rubbing together in a mortar equal weights of metallic mercury and sulphur until globules disappear.

Sulphuret of Silver. This compound is formed by the action of sulphur upon metallic silver, or of sulphuretted hydrogen, or hydrosulphate of ammonia upon the silver salts; the decomposition of hyposulphite of silver also furnishes the black sulphuret. It is insoluble in water and nearly so in those substances which dissolve the chloride, bromide, and iodide, such as ammonia, hyposulphites, cyanides, etc.; but it dissolves in nitric acid, being converted into soluble sulphate and nitrate of silver.

Sulphuretted Paper. To prepare this, soak a paper of very firm texture, not too much glazed, in a weak solution of the muriate of ammonia. It must then be wiped with clean cloths, and carefully dried. The paper is then dipped into a weak solution of the nitrate of silver, and the small bubbles which form on its surface are carefully removed with a camel's-hair pencil. When the paper is nearly but not quite dry, it must be exposed in a closed vessel to sulphuretted hydrogen gas, slowly formed from the sulphuret of antimony and hydrochloric acid; in a few minutes it will become of an iron-brown color, having a fine metallic lustre. It is again to be passed through a solution of silver, somewhat stronger than the first, and dried, taking care that no shadow falls on the paper while it is drying. It is then a second time submitted to sulphuration, and, by careful management, the process is now generally completed. If, however, the paper is not considered to be sufficiently dark, it must be once more washed in the solution of silver, and again subjected to the action of sulphuretted hydrogen. If this paper be allowed to remain in the sulphuretted hydrogen gas after the maximum blackness is produced, it is again whitened with some quickness. This may be accounted for in two ways: the gas may be mixed with a portion of muriatic acid vapor, or a quantity of chlorine sufficient to produce this effect may be liberated from the preparation on the paper to react on the sulphuret of silver. The perfection of these papers consists in having a deep black ground to contrast with the mercurial deposit, by which means the pictures have the advantage of being seen equally well in all positions, whereas Daguerre's pictures on the metal plates can only be seen to advantage at certain angles. The sulphuretted paper may be rendered sensitive in the same manner as the plates by exposure to the vapor of iodine. It is, however, preferable to draw the paper *over* a solution thus formed: A saturated solution of hydriodic salt is made to dissolve as much iodine as possible, and of this liquid 2 drachms are mingled with 4 ounces of water. Care is required that one side only of the paper be wetted, which is by no means difficult to effect, the fluid being so greedily absorbed by it; all that is necessary being a broad, shallow vessel to allow of the paper touching the fluid to its full width, and that it be drawn over with a slow, steady movement. When thus wetted it is to be quickly dried by a warm but not too bright fire; of course, daylight must be carefully excluded. Papers thus treated do not lose their sensitiveness for many days if carefully kept. On examining the sheet after the daguerrotype processes in the camera, and that of mercurialization, have been completed, a very perfect picture is found upon it; but it is still capable of vast improvement, which is by the following simple plan, accomplished in a way which is at once magical and beautiful.

Action of Corrosive Sublimate. Dip one of the pictures formed on the sulphuretted paper into a solution of corrosive sublimate; the drawing instantly disappears, but after a few minutes it is seen unfolding itself, and gradually becoming far more distinct than it was before; delicate lines, before invisible or barely seen, are now distinctly marked, and a rare and singular perfection of detail given to the picture. It may appear at first that the bichloride of mercury dissolves off the metal and again deposits it in the form of chloride. But this does not account for the fact that if the paper has been prepared with the nitrate of silver the mercury disappears and the picture vanishes, the deposit taking place only on those parts upon which the light has acted but feebly; as for in-

stance, on the variation of leaves, leaving those portions of the surface which were exposed to full luminous influence without a particle of quicksilver. When the paper has been either a chloride or iodide, the effect is as above, and the thickness of the deposit is as the intensity of the light has been; consequently semi-tints are beautifully preserved. If the picture remains too long in the solution the precipitate adheres to the dark parts and destroys the effect. The singularity of this operation will be more striking if the picture has been soaked some time in a solution of hyposulphite of soda, then dipped into the bichloride of mercury. As the image disappears a series of circles, formed of a white powder, appear to arise from the paper, generally commencing at the centre and slowly extending over the whole surface; the powder is afterward deposited, and the sheet is buried in the precipitate; but on taking the paper from the liquid and passing a stream of water over it the precipitate is entirely removed from all the parts except the lights of the picture. It will be also found that the invisible image becomes evident without the aid of mercurial vapor by simply soaking for some time in a solution of corrosive sublimate. When these papers are prepared with due care they are extremely sensitive, and if used for copying engravings during light sunshine the effect is *instantaneous*. The great difficulty is to present the paper to the sun and withdraw it with sufficient celerity. In the weak light of the camera a few minutes during sunshine is quite sufficient for the production of the best effects. One great advantage of these pictures over those produced on the plated copper is that the mercury does not lie loosely on the tablet, but is firmly fixed, being absorbed by the paper; therefore, these pictures may be kept without injury in a portfolio. If, instead of immersing the paper in a vessel full of sulphuretted hydrogen gas a stream of the gas is made to play upon it, it assumes a most richly iridescent surface; the various tints are of different degrees of sensibility, but for surface drawings they may be used, and in copying of leaves or flowers, beautiful pictures, which appear to glow with the natural colors, are produced.

Sulphuretting (Sulphurizing). The destructive action of sulphur upon photographic prints. This action is predisposed in the fixing and toning baths and is continued by the sulphuretted hydrogen of the atmosphere. The changes produced by a sulphuretting compound acting upon the red image of a simply fixed print are these: the color is first darkened and a degree of brilliancy imparted to it; then the warm tint by degrees alters to a cold shade, the *intensity* of the whole image is lessened, and the half-tones turn yellow; lastly, the full shadows pass also from black to yellow and the print fades. Now in this peculiar reaction we notice the following points of interest: If at that particular stage at which the print has reached its maximum of blackness, it be raised partially out of the liquid and allowed to project into the air, the part so treated becomes yellow before that which remains immersed. Again, if a print toned by sulphur be placed in a pan of water to wash after a lapse of several hours it is apt to assume a faded appearance in the half-tones. The full shadows, in which the reduced silver salt is thicker and more abundant, retain their black color for a longer time, but if the action of the sulphuretting bath be continued every portion of the print becomes yellow. These facts prove that *oxygen* has an influence in accelerating the destructive action of the sulphur compounds upon positive prints; and this idea is borne out by further experiments, for it is found that moist sulphuretted hydrogen has little or no effect in darkening the color when every trace of air is excluded. When prints are washed in water they are exposed to the influence of the dissolved air which water always contains, and hence the change from black to yellow is produced. Powerful oxidizers, such as chlorine, permanganate of potash, and chromic acid, even highly diluted, act with great rapidity in the degeneration of positive prints; and also *acids* of various kinds develop sulphurization in prints toned by sulphur. Moist sulphuretted hydrogen from the atmosphere is more apt to attack *toned* prints than those that have been simply fixed in hyposulphite of soda. This is especially the case when the toning has been effected with sulphur, as in the case of the mixed bath of hyposulphite and gold, particularly after it has been used for some time and suffered to become acid. The sulphurizing tendency of the air on prints toned in such a bath is very great.

Sulphurizing Compound. A compound tending to sulphurize photographic prints.

Sulphurous Acid. This is a gaseous compound, formed by burning sulphur in atmospheric air or oxygen gas; also by heating oil of vitriol in contact with metallic copper or with charcoal. When an acid of any kind is added to hyposulphite of soda sulphurous acid is formed as a product of the decomposition of hyposulphurous acid, but it afterward disappears from the liquid by a secondary reaction, resulting in the production of trithionate and tetrathionate of soda. Sulphurous acid possesses a peculiar and suffocating odor, familiar to all in the fumes of burning sulphur. It is a feeble acid, and escapes with effervescence, like carbonic acid, when its salts are treated with oil of vitriol.

It is soluble in water. Used in the acid fixing-bath.

Sun. The great source from which all photographic pictures flow. There is nothing new under it, and we are told by Shakespeare that it is a "thief" and "with its great attraction robs the vastsea." But then the moon is also a thief, for her pale fire she snatches from the sun. Photography must fall into line with the other great sources of life and pleasure, and confess itself likewise a thief, because by aid of its greater power its steals from humanity its most inveigling beauties, without which man would be like unto "a world without a sun."

FIG. 205.

Sun Printing. Printing by the direct rays of the sun.

Superposition. A placing above; lying or being situated above or upon something. That which is placed above or upon something else is superposed.

Surgical Photography. A name given to the application of photography to locating nervous affections, to making pictorial record of surgical operations, etc. It is applied to multitudinous cases, even to the eyes and to the interior of the stomach. Special apparatus has been contrived for special work by Dr. Stein, of Vienna; and Mons. Londe, of Paris, has invented a hand-camera particularly useful in depicting the movements of nervous people. It will be better understood by reference to the engraving (Fig. 206.) It acts instantaneously, and may be operated without attracting attention. Thus not only are the ordinary faces of the patient easily obtainable but in cases where rhythmic chorea is the malady and the movements are varied and rapid—almost too rapid to be seen—very helpful studies may be had for the surgeon. (See Fig. 207.) Not only are the erratic movements of the patient caught, but the slightest tremor of the hands is shown by the blurred photograph.

FIG. 206.

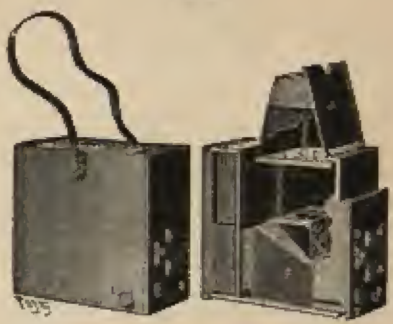


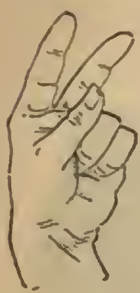
FIG. 207.

In violent hysteria, photography may also be employed with great success. Drs. Charcot, Duchenne, and others have secured effective

pictures of lethargy, catalepsy, and hypnotism of the greatest interest.

The next figure represents the contraction of the muscles of the hand of a helpless patient; other demonstrations of the pressure of the muscles of the hands, neck, feet, etc., are given in the next figure, which, because of the quick succession of these movements was made up of several photographs.

Fig. 208.



By pressure upon the different muscles effected by the employment of the galvanic battery the patient may be caught in some most erratic attitudes. For example, the next figure represents a real Xantippe in action and feature, forced as she is by her dreadful malady against her will.

Fig. 209.

Those who are well acquainted with the distressful attitudes of very nervous people are not surprised at any attitude when control of the palpebral orbicular muscle is lost.

Under the influence of sensorial and sensitive excitements some strange attitudes are taken. By the use of colored glasses Guinon and Woltke have obtained some strange results by affecting the various senses. Of course these glasses must be of varied kinds. We have seen a colored lantern slide of the Sistine Madonna have the effect of starting a religious maniac to such a fine recitation of the Lord's Prayer as to bring tears to the eyes of those who heard him. It is easy to understand, then, how another, at the sound of some instrument suggestive of a circus band, would assume an attitude like this.

Fig. 210.

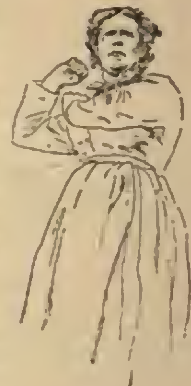


Fig. 211.

With ease and rapidity successive pictures quickly caught, followed by careful analysis, supply very valuble results for the students of disease.

Suspension. In chemistry, the art of holding any substance in solution.

Sutton's Calotype Process. This is Mr. Talbot's process (see *Calotype*), improved by Mr. Sutton, of Jersey.

Swedish Filter-Paper. A special kind of filter-paper made in Sweden, of much better

quality than the ordinary paper and containing no iron.

Swing-Back. A camera appliance, employed in bringing parts of the picture into better focus.

Symbolic Notation. The symbols employed to represent the various elementary bodies are given in this work under their respective titles. The initial letter of the Latin name is used, a second or smaller letter being added when two elements correspond in their initials; thus C stands for carbon, Cl for chlorine, Cd for cadmium, and Cu for copper.

The chemical symbol, however, does not simply represent a particular element; it denotes also a definite weight, or equivalent proportion of that element. (For laws of combination see *Equivalent; Equivalent Numbers*, and *Equivalent Proportions*.)

Formulæ of Compounds. In the nomenclature of compounds it is usual to place the oxygen or analogous element *first* in the case of binary compounds, and the acid before the base with the ternary compounds, or salts; but in representing them symbolically this order is reversed; thus, oxide of silver is written AgO, and never as OAg; nitrate of silver as $AgNo_6$, not NO_6Ag.

The juxtaposition of symbols expresses combination; thus FeO is a compound of one proportion of iron with one of oxygen, or the "protoxide of iron;" if more than one equivalent is present, small figures are placed below the symbols; thus, Fe_2O_3 represents two equivalents of iron united with three of oxygen, or the "peroxide of iron;" SO_3, one equivalent of sulphur with three of oxygen, or sulphuric acid.

Larger figures placed before and in the same line with the symbols, affect the *whole compound* which the symbols express; thus, $2SO_3$ means two equivalents of sulphuric acid; $3NO_5$, three equivalents of nitric acid. The interposition of a *comma* prevents the influence of the large figure from extending farther. Thus the double hyposulphite of soda and silver is represented as follows:

$$2NaOS_2O_2,AgOS_2O_2,$$

or *two* equivalents of hyposulphite of soda with *one* of hyposulphite of silver; the large figure referring only to the first half of the formula. Sometimes however, brackets, etc., are employed, in order to render a complicated formula more plain. For example, the formula for the double hyposulphite of gold and soda, or the *sel d'or*, may be written thus:

$$3(NaOS_2O_2)AuOS_2O_2+4H_2O.$$

In this formula the *plus* sign (+) denotes that the four atoms of water which follow, are less intimately united with the framework of the salt than the other constituents. The use of a *plus* sign is commonly adopted in representing salts which contain water of crystallization. Thus the formula for the crystallized protosulphate of iron is written as follows:

$$FeOSO_3+7H_2O.$$

These atoms of water are driven off by the application of heat, leaving a white substance, which is the anhydrous salt, and would be written simply as $FeOSO_3$.

The *plus* sign, however, is often employed in token of simple *addition*, no combination of any kind being intended. Thus the decomposition which follows on mixing chloride of sodium with nitrate of silver may be written as follows:

$$NaCl+AgNO_3=AgCl+NaNO_3;$$

that is—

Chloride of sodium *added to* nitrate of silver = Chloride of silver *and* nitrate of soda.

Symbols and Molecular Weights of Photographic Chemicals. (From the *Photographic Times Almanac.*)

Name.	Symbol.	Mol. wt.
Acid, acetic, glacial	$H,C_2H_3O_2$	60
boracic, or boric	H_3BO_3	60
carbolic (see Phenol).	C_6H_5OH	94
chlorhydric (see Hydrochloric).		
citric	$C_6H^5O_7+H_2O$	210
digallic (see Tannic acid).		
formic	H,CHO_2	46
gallic	$H,C_7H_5O_5+H_2O$	170
hydrobromic	HBr	81
hydriodic	HI	128
hydrochloric	HCl	36.5
hydrocyanic	HCy	27
hydrosulphuric	H_2S	34
muriatic (see Hydrochloric)		
nitric	HNO_3	63
nitrous	HNO_2	47
oxalic	$H_2C_2O_4,2H_2O$	126
pyrogallic (see Pyrogallol)	$H_3C_6H_3O_3$	126
salicylic	$HC_7H_5O_3$	138
sulphuric	H_2SO_4	98
sulphurous	H_2SO_3	82
tannic (see Digallic acid)	$H_4C_{27}H_{18}O_{17}$	618
tartaric	$H_2C_4H_4O_6$	150

Name.	Symbol.	Mol. wt.
Alcohol, ethyl	C_2H_5OH	46
methyl (see Wood alcohol)	CH_3HO	32
Alum (see Potassium aluminium sulphate).		
chrome (see Potassium chromic sulph.)		
Ammonia, gaseous	H_3N	17
Ammonium, bichromate	$(NH_4)_2Cr_2O_7$	258
bromide	NH_4Br	98
carbonate (see Sal volatile)	$(NH_4)_2CO_3+(NH_4)HCO_3$	175
chloride (see Sal ammoniac	NH_4Cl	53.5
fluoride	NH_4Fl	37
iodide	NH_4I	145
nitrate	NH_4NO_3	80
oxalate	$(NH_4)_2C_2O_4$	124
sulphide	NH_4HS	51
sulpho-cyanate	NH_4CNS	76
Barium, bromide	$BaBr_2$	297
chloride	$BaCl_2.2H_2O$	244
iodide	BaI_2	391
peroxide	BaO_2	169
Bicarbonate of potassa (see Potassium bicarbonate).		
of soda (see Sodium bicarbonate).		
Bichloride of mercury (see Mercuric chloride).		
Bromine	Br	79.8
Borax (see Sodium biborate		
Cadmium, bromide	$CdBr_2.4H_2O$	344
chloride	$CdCl_2.2H_2O$	219
iodide	CdI_2	294
Calcium, bromide	$CaBr_2.4H_2O$	272
carbonate (see Chalk)	$CaCO_3$	100
chloride	$CaCl_2$	111
hypochlorite (see Chloride of lime).	$CaCl_2O_2.CaCl_2$	254
iodide	CaI_2	294
Calomel (see Mercurous chloride).		
Carbonate of ammonia (see ammonium carbonate).		
potash (see Potassium carbonate).		
soda (see Sodium carbonate		
Caustic potash (see Potassium hydrate).		
soda (see Sodium hydrate).		
Chalk (see Calcium carbonate)		
Chloride of lime (see Calcium hypochlorite).		
Chlorine	Cl	35.5
Chrome alum (see Potassium chromic sulph.)		
Copper acetate (see Verdigris).	$Cu(C_2H_3O_2)_2.H_2O$	199
bromide	$CuBr_2$	223.4
chloride	$CuCl_2.H_2O$	170.5
sulphate (see Blue Vitriol)	$CuSO_4.5H_2O$	249.2
sulphate and ammonia	$CuSO_4.4NH_3+H_2O$	245.5
Corrosive sublimate (see Mercuric chloride).		
Epsom salt (see Magnesium sulphate).		
Glauber's salt (see Sodium sulphate).		
Glycerine	$C_3H_5(HO)_3$	92
Gold, perchloride	$AuCl_3+H_2O$	339.2
Green vitriol (see Iron sulph.)		
Hydroquinone	$C_6H_4 2HO$	110

Name	Symbol.	Mol. wt.
Hydroxylamine chloride	NH_2OHCl	69.5
Iodine	I	127
Iron, ammonium sulphate	$FeSO_4(NH_4)_2SO_4+6H_2O$	392
chloride (ferric)	Fe_2Cl_6	325
chloride (ferrous)	$FeCl_2$	127
citrate	$Fe_2(C_6H_5O_7)_2$	598
iodide	FeI_2	310
nitrate	$Fe(NO_3)_2.6H_2O$	288
oxalate (ferric)	$Fe_2(C_2O_4)_3$	376
oxalate (ferrous)	FeC_2O_4	144
sulphate (ferric)	$Fe_2(SO_4)_3$	400
sulphate (ferrous)	$FeSO_4.7H_2O$	278
Lead, acetate (see Sugar of lead	$Pb(C_2H_3O_2)_2.3H_2O$	378
carbonate	$PbCO_3$	266
iodide	PbI_2	460
nitrate	$Pb(NO_3)_2$	330
oxide	PbO	222.4
Lithium, bromide	$LiBr$	87
chloride	$LiCl+H_2O$	60.5
iodide	LiI	134
Magnesium, bromide	$MgBr_2$	184
chloride	$MgCl_2$	95
iodide	MgI_2	246.3
sulphate (see Epsom salt).	$MgSO_4.7H_2O$	246
Mercury chloride (mercuric) (see Corros. subl.).	$HgCl_2$	271
chloride (mercurous) (see Calomel).	Hg_2Cl	235.5
cyanide	$HgCy_2$	252
iodide (mercuric)	HgI_2	454
iodide (mercurous)	Hg_2I	654
Phenol (see Carbolic acid)		
Platinum chloride	$PtCl_4+8H_2O$	479.5
Potassa (see Potassium hydrate)		
Potassium, aluminium sulph. (see Alum).	$Al_2(SO_4)_3.K_2SO_4.24H_2O$	948
bicarbonate	$KHCO_3$	100
bichromate	$K_2Cr_2O_7$	295
bromide	KBr	119
carbonate	$KO_2C_3+2H_2O$	174
chlorate	$KClO_3$	122.5
chloride	KCl	74.5
chromic sulph. (see Chrome alum).	$Cr_2(SO_4)_3.K_2SO_4.24H$	999
citrate	$K_3C_6H_5O_7.H_2O$	324.3
cyanide	KCy	65.1
ferric sulphate	$K_2SO_4.Fe_2(SO_4)_3 24H_2O$	100.6
ferric-cyanide (see Red Prussiate).	$K_6Fe_2Cy_{12}$	658.6
ferro-cyanide (see Yellow Prussiate).	K_4FeCy_6	368.4
fluoride	$KFl+2H_2O$	94
hydrate	KOH	56
iodide	KI	166
nitrate (see Saltpetre)	KNO_3	101
oxalate	$KC_2O_4H_2O$	235
permanganate	$KMnO_4$	158
platino-chloride	K_2PtCl_6	414.9
sulpho-cyanate	$KCyS$	97
Prussiate of potash, red (see Potassium ferri-cyanide.)		
of potash, yellow (see Potassium ferro-cyanide)		
Pyrogallol (see Pyrogallic acid)		
Sal ammoniac (see Ammonium chloride).		
soda (see Sodium carb.).		
tartar (see Potassium carb.)		
volatile (see Ammon. carb).		

Name.	Symbol.	Mol. wt.
Saleratus (see Potassium bicarbonate).		
Salt, common (see Sodium chloride).		
Saltpetre (see Potassium nitrate).		
of Chili (see Sodium nitrate).		
Sesqui-carbonate of soda (see Sodium carbonate).		
Silver, acetate	$AgC_2H_3O_2$	167
bromide	AgBr	188
carbonate	Ag_2CO_3	276
chloride	AgCl	143.5
citrate	$Ag_3C_6H_5O_7$	513
fluoride	AgFl	127
iodide	AgI	235
nitrate	$AgNO_3$	170
nitrite	$AgNO_2$	154
oxalate	$Ag_2C_2O_4$	304
oxide	Ag_2O	232
sulphide	Ag_2S	248
Soda, caustic (see Sodium hydrate).		
Sodium acetate	$NaC_2H_3O_2,3H_2O$	190
biborate (borax) . . .	$Na_2B_4O_7,10H_2O$	382
bromide	NaBr	103
bicarbonate . . .	$NaHCO_3$	84
carbonate	$Na_2CO_3,10H_2O$	286
chloride	NaCl	58.5
citrate	$Na_3C_6H_5O_7$	258
hydrate	NaHO	40
hyposulphite . . .	$Na_2S_2O_3,5H_2O$	248
iodide	NaI	150
nitrate (see Chili saltpetre)	$NaNO_3$	85
sulph-antimoniate . .	$NaSbS_4$	241
sulphate	$Na_2SO_4,10H_2O$	322
sulphide	$Na_2S,9H_2O$	240
sulphite	$Na_2SO_3,7H_2O$	252
thio-sulphate (see hyposulphite).		
Strontium, bromide . . .	$SrBr_2,6H_2O$	355.5
chloride	$SrCl_2,6H_2O$	266.5
nitrate	$Sr(NO_3)_2$	211.5
Sugar of lead (see Lead acetate)		
Sulphate soda (see Sodium sulphate).		
Tannin (see Digallic acid) .		
Thymol	$C_6H_3(CH_3(C_3H_7)CO)O$	177
Tin, chloride (stannic) . .	$SnCl_4$	260
chloride (stannous) . .	$SnCl_2,2H_2O$	225
Uranium, bromide . . .	$UBr_3,4H_2O$	552
nitrate	$UO_2(NO_3)_2,6H_2O$	504
sulphate	$UO_2(SO_4),3H_2O$	302
Verdigris (see Copper acetate)		
Vitriol, blue (see Copper sulph.)		
green (see Iron sulphate) .		
white (see zinc sulphate) .		
Washing soda (see Sodium carbonate).		
Wood alcohol (see Alcohol methyl).		
Zinc, bromide	$ZnBr_2$	225
chloride	$ZnCl_2$	136
iodide	ZnI_2	319
nitrate	$Zn(NO_3)_2,6H_2O$	296
sulphate (see White vitriol)	$ZnSO_4,7H_2O$	287

Symmetrical Doublet. An objective composed of two equal single lenses, symmetrically arranged in proportion to the diaphragm, which stands between the two lenses. They are free from distortion. Steinheil's aplanat, Voigtländer's euryscope, etc., belong to this class.

Symmetrical Triplet Lens. This combination, the invention of Mr. Thomas Sutton, of Jersey, consists of two equal achromatic plano-convex lenses, one at each end of a tube, placed with its convex side outward, and a small double concave lens of equal radii placed exactly midway between them. In contact with the double concave lens a small stop is placed. It is evident that in this combination a small oblique pencil is incident excentrically upon the front convex lens, that its axis after suffering deviation passes centrically through the concave lens without suffering further deviation, and that it is then incident excentrically upon the posterior convex lens, from which it emerges in a direction parallel to that of incidence. This is true of every oblique pencil, and their axes all pass through a common point, which is the centre of the symmetrical combination. The focus of an oblique pencil is in every optical instrument a disk of light, and not an exact point. The size of this disk is reduced by using a small stop. When it is *sufficiently* reduced by using a *sufficiently* small stop, the focus upon the screen is said to be good. In that state a ray which passes through the centre of the symmetrical triplet is one of the rays which compose the small disk or good focus, because it is at the centre of the stop. The focus is therefore at the point where the axis of the pencil meets the focussing screen—an absolute necessity for obtaining an image free from distortion.

Synthesis. The method of determining the nature of bodies by composition, the elements being caused to unite and produce the compound. Thus the *synthetical* is the opposite method to that of analysis, or the *analytical*.

Syrup. A thick solution of sugar in water. In the preparation of syrups care should be taken to employ the best refined sugar, as they will be thus rendered less liable to spontaneous decomposition; and if made with distilled water, or filtered in rain water, will be perfectly transparent, without the trouble of any clarification.

Syruped Collodion. Collodion covered with a coating of syrup.

T.

Table of Distances—for use with detective cameras—at and beyond which all objects are *in focus*. Calculated for a confusion disk of less than the $\frac{1}{100}$th of an inch. By J. J. HIGGINS, A.M., M.D.

Equiv. Focus.	f5	f6	f7	f8	f9	f10	f11	f12	f13	f14	f15
In.											
5	42	35	30	26	23	21	19	17½	16	15	14
5½	50½	42	36	32	28	25	23	21	19	18	17
6	60	50	43	38	34	30	27	25	23	21½	20
6½	70½	59	50	44	39	35	32	29½	27	25	23½
7	82	68	59	51	45	41	39	34	31	29½	27

Table Stand. A studio stand for very large cameras. It has the shape of a four-legged table on casters, with powerful rack, and mechanism for lowering and raising.

Tabloids. For the convenience of tourists and amateur photographers who may wish to develop or fix their plates, or tone prints, etc., while travelling, many standard photographic preparations, such as pyro, eikonogen, metol, toning and fixing powders, etc., may be obtained in the form of lozenges or "tabloids," or cartridges.

Talbot-Klic Process. In 1852 and 1858 Talbot patented methods for producing intaglio printing-blocks, which were later modified and improved by Klic. Modified applications of these processes are now commonly used for producing both intaglio and relief blocks for photogravure and typographic printing. (See *Wilkinson's Photo-Engraving*, etc., and the same author's *Photogravure*.)

Talbotype. The name given to the calotype process, in honor of its discoverer, Henry Fox Talbot, Esq. (See *Calotype*.)

Talc. Soapstone. Colorless, greasy feeling mineral, used as talc powder for preparing glass plates for stripping films.

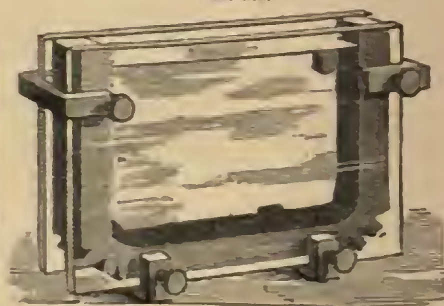
Tally-Board for Printers. Used by printers for registering or tallying the number of prints made from a given negative. Two hands are supplied to the register—one to number the prints in order and the other to tally them as they are printed. For example, when the tally hand arrives at the

FIG. 212.

register hand you are told at once that the order is finished.

Tank. Made of two sheets of glass clamped together with a strip of India rubber

FIG. 213.



between. Used for exhibiting living animals and chemical reactions in the magic lantern.

Tannic Acid. $C_{27}H_{22}O_{17}$. A yellow substance, soluble in water and alcohol. Used to harden the gelatine film. For paper prints alum is better, as tannic acid colors them yellow.

Tannin Process. A collodion dry-plate process, introduced by Major Russell, in which the collodion plates on gelatine substratum, after coating and washing, are flowed with tannin solution. After drying they will keep for some time.

Tartaric Acid. Tartaric acid is found in the fruit of several plants, but more especially in the grape in combination with potassa, and is manufactured in large quan-

tities from the bitartrate of potassa, a crystalline substance deposited on the sides of wine casks. Tartaric is a crystallizable acid, very soluble in water, and but little so in alcohol. It is converted into the oxalic by the action of nitric acid and heat. To obtain it dissolve the bitartrate of potassa in hot water, and add carbonate of lime; filter and wash the precipitate, diffuse it through water, and add dilute sulphuric acid; filter again, and evaporate the solution; crystals will form. Tartaric acid is used in photography in conjunction with protosulphate of iron to form a developing agent for negatives instead of acetic acid. It has also been used in the preparation of ready-sensitized paper, and and as a retarder in developers and with sensitizers.

Tartaric Acid Prints. Immerse the paper in an 80-grain solution of tartaric acid in water, dry, and then float on a 50-grain solution of aceto-nitrate of silver; dry again. Expose in a pressure-frame under a negative, and fix in the usual way.

Tartrate. A salt formed by the union of tartaric acid with a base.

Tartrate of Iron and Ammonium. Ammonio-tartrate of iron. A light-sensitive combination used in the blue-print process. It acts similarly to ammonio-citrate of iron.

Tartrate of Potash. This salt, commonly known as soluble tartar, is formed by neutralizing with subcarbonate of potassa the excess of tartaric acid in the bitartrate of potassa. The form of the crystal is a right rhomboidal prism, very soluble in water, attracting moisture when exposed to the air. The crystals contain 2 parts of water at a temperature not exceeding 248° F.

Tartrate of Silver. A union of silver with tartaric acid. The tartrate of silver possesses some extraordinary peculiarities. Papers may be prepared either by spreading the tartrate at once over the surface, or still better, by soaking the paper in a solution of Rochelle salts (tartrate of potash and soda), and then applying two washes of the solution of nitrate of silver. The first action of light is very feeble, but there gradually comes on a stronger discoloration, which eventually proceeds with rapidity, and at length blackens to an extent beyond almost every other paper. This discoloration may be wonderfully accelerated by washing over the tartrated paper with a very dilute solution of the hydriodate of potash, during the process of darkening. It is not easy to use this when copying anything, but there are cases in which the extreme degree of darkness which this preparation acquires renders it valuable. The acetate of silver comports itself in the same manner as the tartrate. The citrate, oxalate, etc., are only interesting as forming parts of the series of argentic preparations which exhibit decisive changes when exposed to light. The methods of rendering them available will be sufficiently understood from the foregoing. Tartrate of silver is used for preserving silvered paper, but the citrate of silver is preferable.

Tartrate of Soda. Take 300 grains of carbonate of soda, dissolve in water, and add 400 grains of bitartrate of potassa. The soda uniting with the excess of tartaric acid in the bitartrate, forms this salt, and carbonic acid is given off. The salt crystallizes in large prismatic crystals, which are soluble in 5 parts of water.

Tanner's Wet-Paper Process. Take French or German paper and steep it from ten to twenty minutes in a solution of *pure* iodide of potassium, 500 grains to 1 pint of water. A proportion of the 500 grains may be bromide of potassium or chloride of sodium, if greater intensity is desired. After immersion hang up to dry. When dry sensitize with a solution of nitrate of silver, 50 grains; water, 1 ounce; acetic acid, 1 drachm, by floating; blot off with white bibulous paper quite moist, laying the *back* of the sensitized sheet upon the bibulous paper. Allow it to drip a few minutes, and then place it in the dark-slide, and expose in the camera. After the exposure, which should be effected as soon as possible, the paper is removed and placed face downward upon a glass plate, containing a nearly saturated solution of gallic acid. The image soon develops, and is fixed in hyposulphite of soda, dried, and waxed in the usual way.

Tannin. A peculiar vegetable principle, named from its power of converting skins of animals into leather. It is prepared by precipitating an infusion of galls with a concentrated solution of carbonate of potash, avoiding excess; wash with *ice-cold* water, dissolve in dilute acetic acid, filter, precipitate by acetate of lead; wash the precipitate with water; suspend it in water; decompose it by sulphuretted hydrogen, and evaporate

the filtered liquid in vacuo or over sulphuric acid.

Tannin, in its pure state, is perfectly white, but acquires a yellow color from the action of the air. It is a powerful astringent and reddens vegetable blues. It unites with the bases, forming salts called *tannates*, which are characterized by striking a deep black with the per-salts of iron. Tannin is used in photography as a preservative.

Tannin Dry Process. (See *Russell's Dry Process.*)

Taste. That power of the mind which is conversant with the beautiful, both in Nature and art. An intellectual perception of any object, blended with a distinct reference to our sensibility of enjoyment or dislike. Coleridge defines taste as "a metaphor taken from one of the mixed senses, and applied to objects the more purely organic, and of our *moral sense*, when we would apply the co-existence of an immediate personal dislike or complacency." Now, by the constitution of man's nature every exertion of human activity, in the pursuit of the good, the beautiful, and the true, combines a sense of pleasure, or the contrary, with the perception of their respective objects; and this fact would justify the widest application of the metaphor. While, however, in the case of the true, this co-existent pleasure has not received any distinctive appellation, and while conscience, as comprehending the sense of approbation or disapprobation, is characteristically applied to the moral energy, that of taste has been confined to the perception of beauty and the accompanying gratification. But taste, like all other metaphorical terms, is extremely inaccurate, and by directing attention exclusively to this element of pleasure, it has led to a very inadequate conception of the true nature of the faculty which it designates. Thus Hutcheson maintains that the faculty is peculiar, and is a sense which, similarly to the other senses, procures a pleasure totally distinct from a cognition of principles, or of the causes, relations, and usages of an object; that beauty strikes at first sight, and that knowledge the most perfect will not increase the pleasure to which it gives rise; and lastly, that all the diversity of sentiments excited in different minds by the beautiful arise solely from the modifications of the sense by association, custom, example, and education.—*P. H. C.*

Tatum's Photographic Canvas. This is a patented process for rendering canvas capable of receiving a photographic impression in such a manner as not to interfere with the oil ground and thus enable the artist to paint the portrait without the difficulties and accidents usual to other methods.

Taupenot's Dry Process. The cleaning of the glass for this process is a most important desideratum, as much of its success depends upon this. Glass that has been used must be soaked for some hours in a solution of common potash 1 ounce, water 1 pint, before cleaning. Put the glass on a quire of white paper, the side which you do not prepare upward; take three *pads* as thick as the fist, made of fine polishing cotton; with the first cover the glass with a mixture of tripoli 1 drachm, with nitric acid 15 minims, water 1 ounce; with the second, remove carefully the layer of tripoli which you have just applied; with the third rub the glass afresh to satisfy yourself that it is quite clean. It is necessary that the two last operations should be quickly performed without giving the tripoli time to dry; you must also begin at the left corner at the bottom, work toward the right corner, and so go up the glass horizontally without passing over that which has been done. The first surface being polished, the same operation is performed to that which it is intended to sensitize. The palm of the hand is passed over the four edges of the plate, to make sure that no dust remains attached to them; lastly, a silk handkerchief is passed lightly over the two surfaces, and the glass is put into a grooved box, or better, upright against the wall. At the moment of applying the collodion it is only necessary to pass over the glass a gilder's brush, which will remove the dust which may have fallen upon it.

The Collodion. It is very essential that the collodion film should be very adherent to the glass, and that it should be in a state entirely opposite to collodion which we wish to transfer; that is, it should be clear, may contain a little water, and ought to include the least possible amount of alcohol.

These qualities are obtained by

Ether, sp. gr. 0.759	6 drachms.
Alcohol, sp. gr. 0.848	2 "
Gun-cotton	4 grains.
Iodide of Cadmium	4 "
Bromide of Cadmium	½ grain.

Coat the plate in your usual manner, and sensitize in a bath of nitrate of silver, 35 grains; water, 1 ounce; then place it in a dish of clean water and pass the water over and over it several times; then into a second dish of water and repeat the operation. Lastly, pour over it a great quantity of water, and finish by washing it twice with distilled water. Let it drain for a minute or more from one corner, and then pour on the albumen.

The Albumen. To make the albumen coating, take

Albumen	2¼ ounces.
Distilled Water	¾ ounce.
Liquor Ammonia	30 minims.
Iodide of Potassium or Ammonium	10 grains.
Bromide of Potassium or Ammonium	3 "

Put into a dish the iodide, the bromide (and if you desire, a little rock-candy), and dissolve them in the water; add the albumen and ammonia; beat them up together as long as possible. The next day filter the solution through clean cotton-wool, or filtering-paper, and bottle it off in 4 or 6 ounce bottles; fill them full, and cork them up tight. It will keep thus as long as you may wish. If it gets thick or forms threads, filter before using. Pour the albumen plentifully upon the sensitized collodion on one side of the glass and take care that it spreads in a well-united sheet, and that it reaches as quickly as possible the corner at which it is drained off. If the plate has been well washed, and the albumen spread without stopping, there is every chance of getting a good picture; but if either of these points is wanting, veins will be perhaps caused, traversing the whole negative, and which cannot be seen before development. The albumen which is poured off the glass will do again, if filtered. It should then be left to dry, which will take five or six hours. When thoroughly dry sensitize with nitrate of silver, 40 grains; distilled water, 1 ounce; crystallized acetic acid, 40 minims; wash thoroughly as before for the collodion, drain and dry. Add occasionally to the silver bath portions of a 50-grain solution of nitrate of silver to keep it up to its full strength.

Development. To effect this successfully, take of a

Saturated Solution of Gallic Acid	2¼ ounces.
Pyrogallic Acid	1 grain.
Alcohol	25 minims.
Acetic Acid, No. 8	30 "

Dissolve the gallic acid in cold water, decant it and add the alcohol, which will dissolve any particles left by the water; then the pyrogallic acid; lastly the acetic acid, and filter. At the time of using add the quantity of silver solution required. Serious inconveniences arise from using any portion of the sensitizing bath. It should be understood that this formula must be modified according to the images that are to be developed. If the exposure is insufficient, a little more nitrate must be added; if, to get more equality and less contrast between the lights and shadows the exposure has been very long, it is necessary to diminish greatly the proportion of gallic acid, to increase that of acetic acid three or four times, and begin the development without the silver. The best method is to put the developer in a flat dish, and immerse the plate in it quickly, avoiding bubbles; raising it occasionally to note the progress of development. It should be slightly over-developed, as it loses intensity in the fixing-bath. The developer can be used until it becomes black, when it must be thrown away. You must not be discouraged at the length of time required for development, as it will sometimes require several hours to get a good negative; one of the great advantages of this process is, that a good picture can, almost always, be obtained after any kind of exposure. The less nitrate of silver used the more clear and in keeping will be the plate; as little as possible, therefore, should be added.

The Fixing. After having developed the image it should be carefully washed and placed in a solution of hyposulphite of soda, 1 ounce; water, 10 ounces. If the negative is feeble, it may be put into a 3 per cent. solution, and left there only until the edges begin to lose the iodide a little, and then washed. This plate will give a very soft and agreeable positive. (For several modifications of this process see INDEX.)

Taupenot's Paper Process. Take paper salted in the usual way; soak it in a solution of iodide of iron, and when blue, wash in water; soak in a weak alcohol and water solution of nitrate of silver, saturated with iodide of silver (*i. e.*, the negative collodion nitrate bath); then coat with iodized albumen. When dry coat the albumen surface with aceto-nitrate of silver; dry and expose a few seconds under a negative, develop with a saturated solution of gallic acid; tone in

sel d'or bath, and fix in hyposulphite of soda. Fifteen seconds' exposure to gaslight is sufficient for good results. This paper may also be used in the camera for negatives

Technical. That method of speaking which is proper, or peculiarly appertaining to any given art. Artists and amateurs are accustomed, when they talk of matters relating to the arts, to employ many expressions which are not introduced into any language, or at least, do not bear the same signification. This species of conversation is not without its advantages. The terms it employs are often arbitrary, but they are much clearer than any other would be to the artist or connoisseur, inasmuch as he has habituated himself to combine with them, and with them alone, the ideas meant to be conveyed; and they besides, often save a roundabout way of expression. But this stated, we are bound to add that they should never be introduced into books, excepting only such as are addressed *especially* to the practisers of art, for in any work designed for the purposes of general information they merely tend to mystify and confuse the reader.

Technique. In photography a term used to indicate *workmanship.* The technique of a painting is its drawing, light and shade, color and perspective, or, more plainly, their management in contra-distinction to its sentiments or ideas, or conception, if you will. In whatever way the photographer poses, lights and generally manages his model, that is called technique. It does not include the after chemical treatment of the negative, for that pertains to the manipulation. As to the sentiment, idea, or conception, or the carrying out of any of these to any degree, that is still another story.

Technique of Pen-Process Drawing. It goes without saying that the process-artist should confer with the printer of the book as to style of type to be employed in the work, headlines, tail-pieces, etc. In a word, the whole should be carefully planned before any actual mechanical work is done. When a residence, to cost $15,000 or $25,000 is projected, an architect is employed to carefully plan every detail. A like amount of money should not be expended upon the publication of a book until the wished-for result has been carefully provided for, so far as foresight can provide, as to mechanical details of type, proper binding, etc. These, supplemented by plates adapted to the purpose, secure a far better result than the usual hit-or-miss methods.

Such illustrators of our time as Harvey Fenn, E. A. Abbey, Geo. Wharton Edwards, and E. J. Meeker never fail to add greatly to the value of the works embellished by them.

Drudgery must be endured in beginning most pursuits.

A great facility of hand and delicacy of touch must be secured if one would succeed with the pen. The pencil offers no such incentive to excellence because the pencil line can be easily erased. In a process-drawing, the certain pen-line must remain, and a habit of thoughtful accuracy is essential.

Facility of hand can be cultivated by much practice of the following exercises: The endeavor should be to lay a *tint* with such a pen, fine or coarse, as one may choose to employ. The "T" pens, for coarse work, Gillott's No. 404 and No. 303, are good. The favorite pen with the writer is, however, the Spencerian No. 1, Dbl. elastic. With this pen lines may be as lightly described upon paper as a feather is floated in the air.

Higgins' ink, or that known as *Encre de Chine*, may be used.

One may begin by describing a circle of good size, say as large as the circumference of a desk mucilage bottle. With a pencil, rule lines vertically and horizontally, dividing the circle into four equal portions. The circle has now been delineated and divided with a *pencil.* Begin at upper left-hand portion with the *pen*, lay curved lines *distant from each other twice the width of the line employed.* This rule may be safely adopted by the artist for reproduction work. When complete, the fourth of the circle should appear to the half-closed eye as a tinted ground. It is important to at once form the habit of starting exactly upon the pencil line at the right and ending upon the line at the bottom. This division tinted from right to left, next take its neighboring division and tint it from left vertical line to right horizontal. Treat the lower half of circle in the same manner. When the ink is dry, gently erase the pencil marks with rubber, and you have a circle tinted, with a white cross in the centre. After some pages of this work, describe a second circle with the pencil, divide it vertically and tint the left- and right-hand portions as before.

Describe a third, divide it horizontally, and tint the upper and lower halves as before. After two days of work, increase the size of the circles by, say one-fourth of an inch, or better, one-half of an inch, if you can possibly manage it.

After some days of this preparatory work, review the whole, but this time trusting wholly to the eye for guidance, relying no longer upon the help of the pencil lines.

Now it becomes important to acquire a method of forming lines and tints in squares. Rule, or better, sketch a series of squares, each side, say, 1¼ inches. No. 1, divide by horizontal and vertical lines. Tint lower left-hand square and upper right-hand square. No. 2, divide by diagonals and tint each by lines parallel with sides of square. No. 3, describe a diamond inside; tint horizontally. No. 4, the same, but tinted vertically. No. 5, the same, but tinted *outside* the diamond.

Now pencil some Greek frets, double line. Tint, and remove the pencilling. Progress can now be readily seen. Draw now with pencil a series of interlocking diamonds horizontally delineated. Tint the *outer edge* of one, the *inner* diamond following.

There should now appear in your work the ease of a master hand; no appearance of hesitation or doubt. Now reproduce the whole series of exercises from memory, unaided by the pencil outline.

He who can draw nothing but what is before him, loses the best portion of the art. From this stage on, the mind must add the riches of its resources to the efforts of the eye and the hand.

Now procure some simple models of wood, and some low models of casts of architectural movement. Get a cube, a cylinder, and a sphere of wood; these are elementary forms found in Nature. Houses are huge cubes. Tree-trunks are cylinders. Old iron kettles are spherical in light and shade. Space forbids further hints; and the workman will readily supply his own. If one chooses to add a wooden cross, and an open triangle and a pyramid, such will be found most useful. Curtain off the window at lower portion until the light *falls* upon models. Arrange them for cast shadows. Mingle books, vases, a hat or glove, in the composition. Begin with a simple group. Pencil-in the shadows. Take the pen and tint these, *cross-hatching as little as possible.* Try to secure requisite strength by suitable tinting. After practice with the straight-line models, take up the sphere. Place with it a graceful pitcher or vase, even a wine-glass. Note the ellipse formed by the top of the glass. Note the "down-in look" given by the shade. *Let all shadow tints take the course of the surface upon which they fall,* be it upon a book or table. Now it is to be presumed that you are familiar with proportional measurement, secured by holding the pencil or pen at utmost length of the arm outstretched from the body. Upon the pen mark with the thumb the apparent size of the principal object. Now ascertain what relation, whether half the size or three-fourths, the other objects in the group sustain, and sketch accordingly. In tinting the shadows use the utmost care to begin and end upon pencil lines, as in the elementary exercises. Think long before you draw a line. Let it be clearly well-defined. No random touches, as if in search of the true line. This maxim will serve you well in all your after work.

Come on now to design. Set up a bare branch, follow the intricacy and variety of its details and graceful taperings and tintings. Ere you have half planned the serpentine lines, you will think how blind you have always been to the loveliness of Nature.

Next take flowers or a weed. Delineate all of the plant—flower, bud, leaves, and roots. Note the form of blooms and leaves when turned from you. Draw nothing as you *suppose* it to be. Maxim two for recollection.

If you intend to take up chalk-plate work you must form an idea of the normal human face. With mental image in mind, departures from the usual standard are quickly noted.

In brief: The classic figure was seven and a half to eight heads high; from crown of head to under part of chin being the eighth portion of a man. Arms outstretched, from finger-tip to finger-tip is the same length as from toe to crown. Allowing two heads for width of body from shoulder to shoulder, the arms and hands must then be each three heads long. Divide now the head into *nose-lengths.* It is four nose-lengths in all. From crown to forehead, one nose; the forehead, one nose; the nose; and from nostril to foot of chin another nose—so that half a man's head should be below the root of his nose. Minor details now are: The width of a face

is two nose-lengths; the neck is two noses in diameter; the shoulders, eight noses; the ear, one nose-length—and it should, when symmetrically placed, be horizontally on a line with the nose.

The space between the eyes, half a nose-length; the nostrils the same length as the width; the eyes the same length as the space between them, so that the centre of the eye-balls should be perpendicular with the extreme ends of the mouth. The thickness of the upper lip should be one-eighth of its length, and of the lower lip, one-fifth.

The space between the chin and throat-pit should be the same as the diameter of the neck.

Women and children differ. A woman's head is smaller, the shoulders are but six and a half noses to eight to the male. Children have much larger heads propor-

FIG. 214.

A head, classic standard.

tionally. At four years a child only measures five and a half heads. At nine years six heads, at fifteen years six and a half, at seventeen years seven heads. Do not, until after some years, attempt to idealize or improve upon your subject. Take your hand-camera and stroll about the street, or the parks of any large city, and gather in your studies. A series I saw of views taken at a country cattle show formed a collection excelling in interest any series sketched by even famous artists. The lens places a great power in the hands of earnest workers.

Teleo Lens Attachment (Steinheil's). This attachment is for photographing distant objects on an enlarged scale. It does away with the long-focus lens and lengthened

FIG. 215.

camera. The attachment is screwed to the lens as shown in the figures, and can be used with any lens the light-intensity of which is not less than *f/7*. The teleo attachment for the Steinheil lenses fits into the same flange as the lenses themselves, and the back combination protrudes slightly into the camera box. The enlargement is determined by the extension of the bellows, increasing with the distance of the ground-glass from the lens, and the focussing is accomplished by the rack and pinion, by which the separation between the front and back lens combinations can be varied. In ordinary practice the ground-glass is first placed so as to secure the approximate degree of enlargement desired, and then the focus is adjusted by the rack and pinion on the teleo attachment. Should it appear that the sharp image is not of the exact size desired, the ground-glass is moved in or out and the focus again adjusted. A very little practice

will secure the exact size of image desired. The focussing should be done with the full aperture of the lens.

Tele-Photographic Lens. Several forms of objectives have recently been introduced, combining the properties of the telescope and the usual photographic lens. These instruments are used to obtain large images of distant objects, and promise to be of great utility in certain branches of work. The idea is an old one, but tele-photographic lenses as used to-day are the result of modern investigation. The reader may gain full particulars of the various makes by referring to opticians' and supply dealers' catalogues. There are several objectives bearing this name, one the invention of Mr. T. R. Dallmeyer, another devised by Dr. Miethe. The latter consists of a convex lens of considerable length of focus and a concave lens of short focus. These are placed a certain distance apart, depending on the difference of the two foci. By the laws of optics this arrangement projects an inverted image of an object at a long distance from the lenses. The size of the object is greater the closer the lenses are together and the greater the difference between the foci. To obtain good images the lenses are of special form and achromatic. The whole camera looks very like a Galilean telescope. By substituting an ordinary opera-glass for the objective on the camera and drawing it out, a fairly good picture will be obtained on the ground-glass of the camera.

Dallmeyer's Tele-photographic Lens is composed of only two elements, and the image given by it is primary and inverted. The anterior element is a positive lens, preferably of large aperture and short focus, while the posterior lens is a negative element of some *fractional* portion of the focal length of the anterior positive lens. Given the same extension of the camera in an experiment it will be found that the shorter the focus of the posterior lens, as compared with that of the anterior lens, the greater is the size of the primary image produced.

Tele-Photography. The telegraphic transmission of pictures of natural objects by the aid of light. As yet experimental.

Telesmatic Apparatus. An apparatus invented by Fontayne many years ago, for printing photographs at a very rapid rate. It is out of use, but it is worth describing. Mr. H. H. Snelling, says: "It is very simple, and acts with as much precision as that of an astronomical apparatus. In one hour 4000 or more positives on paper can be printed from one negative. The sensitive paper is rolled upon a cylinder, which, set in motion by clockwork, unrolls itself slowly and regularly. The whole is contained in a dark box furnished with a single aperture. The negative slides within this aperture, and the sensitive paper is so arranged beneath it, that for a definite, but very brief period, it touches the negative. The mechanical apparatus is also so constructed, that the paper remains for about a second in contact with the negative, and at the same time, by an equally rapid motion, it opens and shuts a cap placed over the negative; while over the cap a condensing lens is placed, which throws the concentrated rays of the sun on the negative, and consequently on the negative paper. The complete action of the machine is accomplished in the short space of a second of time; during which the paper is brought into contact with the negative, the cap opens, the paper remaining exposed to the light about a second, and the cap is closed; again the paper moves, the impressed portion travels on, and a fresh portion comes under the negative, to be impressed in its turn. By accelerating the motion of the machine, this action may be repeated one hundred times in a minute. From 200 to 250 proofs are printed on each sheet of paper; they are removed to the dark-room, and developed and fixed in the usual manner."

Tele-Stereoscope. This instrument simply consists of four rectangular pieces of looking-glass mounted upon a flat staff of wood four feet long; the two pieces fixed in the middle of the staff are inclined at an angle of 45°, the vertex being toward the observer. Two eye-holes, about an inch in diameter, are cut through the wood to admit the reflexed images from the fixed mirrors into both eyes. Each mirror at the *end* of the staff is hinged at its base, in order to adjust the degree of outward inclination for objects more or less distant, and to direct the first reflected image on to the two mirrors of 45°, and from thence to the eyes. Some of the effects of this piece of apparatus are very remarkable; objects so far distant that the ordinary angle of vision of the two eyes is not sufficient to enable one to appreciate their size and relative posi-

tions are brought into high stereoscopic relief. On the other hand, the use of the instrument on near objects is instructive, but not satisfactory in producing true stereoscopic effect—for, on standing at the end of a row of pillars, or trees, both sides are seen at the same time, producing a double image, the outer mirror requiring to be adjusted to a range of at least fifty yards before agreeable or correct vision can be obtained.

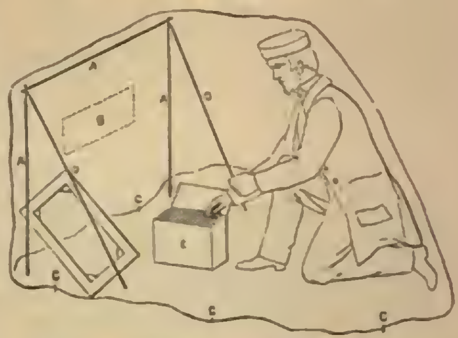
Temperature. The amount of sensible heat a body contains is called its temperature. The temperature of the chemicals used in photography and of the surrounding atmosphere greatly influences photographic operations. Very high or very low temperatures have equally disadvantageous effects. Neither the rooms nor the solutions of any kind should rise higher than 85°, or sink lower than 60°, if uniform results are desired.

Temporary Support. See certain processes, such as the carbon process. The sensitive surface is first manipulated upon a base known as a *temporary* support, and afterward transferred to a final support.

Ten per Cent. Solutions. Measures are graduated to ounces, drachms, and minims, the drachms containing 60 minims, the ounces 8 drachms, and consequently 480 minims. The removal of the cipher shows that an ounce of a proper 10 per cent. solution contains 48 grains; not 48 grains *and* an ounce of water, but 48 grains in an ounce. Ten ounces are equal to 4800 minims, and removing the last cipher, 480 grains, the Troy ounce, will be seen to be the quantity required to make the required solution. To make ten ounces of a correct 10 per cent. solution, then, it is only necessary to place one Troy ounce of the solid in a measure, and fill it up to ten ounces. A simple rule, easy of application, is to put any number of grains into a measure, add a cipher to that number, and fill it up to that number of minims. For example, take the avoirdupois ounce of 437.5 grains, the ounce of ordinary buying and selling, and, discarding the fraction, add a cipher to the number, and 4370 minims is the quantity indicated. Place the ounce in the measure, and fill up to nine ounces and fifty minims.—*Dr. J. Nicol.*

Tent. A room made of canvas or other cloth, and set up upon poles, or sustained by other contrivance; used for changing or developing plates. It may be made variously, consisting of any framework with a light-tight covering. (See Fig. 386.) It should be well pinned to the ground. A colored light is admitted at B.

FIG. 216.



A good photographic tent, weighing but eleven pounds, may be made in a conical form, of black lined with yellow or orange-colored calico, 7 feet high by 4½ in diameter, having around its base a black curtain to lie flat upon the ground to exclude the light. Into the interior of the tent sew four India-rubber air-tubes, sufficiently large, when inflated, to keep the calico fixed in a circular form. Connect these with eight smaller ones, so that on the application of a bellows to a nozzle fitted into the second air-tube, the whole four tubes can be simultaneously inflated. To the apex of the tent attach a ring, and a cord fifteen or sixteen feet long, with a weight at the end. In sewing the strips of cloth composing the tent, one should be made sufficiently wide to lap two feet over the next at the seam, which should be sewn only half its length from the top; this will form the door, and may be fastened on occasions by buttons and loops. Attached to the bottom, under the curtain, at suitable intervals place loops for securing it to the ground by pins, or a sufficient quantity of shot may be sewed into the base to keep it in its place. Arrived on the ground of operation select a place for the tent under a tree, or other convenient object; throw the cord over a branch and fasten the end to a tent pin driven into the ground, after drawing the tent up to its proper height; then inflate the air-tubes. This tent when taken down will occupy but very small space in packing. There are many other forms of tent.

Ternary Compounds. As the various elementary substances unite with each other to form binary compounds, so these binary compounds again unite and form *ternary* compounds.

Compound bodies, however, do not, as a rule, unite with simple elements. In illustration, take the action of nitric acid upon silver. No effect is produced upon the metal until *oxygen* is imparted; then the oxide of silver so formed dissolves in the nitric acid —in other words, it is necessary that a binary compound should be first formed before the solution can take place.

The mutual attraction or chemical affinity exhibited by compound bodies is, as in the case of elements, most strongly marked when the two substances are opposed to each other in their general properties.

Thus, *acids* do not unite with other acids, but they combine instantly with *alkalies*, the two mutually neutralizing each other and forming "a salt."

Salts therefore are ternary compounds, produced by the union of acids and bases; common salt, formed by neutralizing muriatic acid with soda, being taken as a type of the whole class.

General Characters of the Salts. An aqueous solution of chloride of sodium, or common salt, possesses those characters which are usually termed saline: it is neither sour nor corrosive, but, on the other hand, has a cooling, agreeable taste. It produces no effect upon litmus and other vegetable colors, and is wanting in those energetic reactions which are characteristic of both acids and alkalies; hence, although formed by the union of two binary compounds, it differs in properties essentially from both.

All salts, however, do not correspond to this description of the properties of chloride of sodium. The carbonate of potash, for instance, is an acrid and alkaline salt, and the nitrate of iron reddens litmus-paper. A little reflection shows the cause of such differences. A perfectly neutral salt is formed when a strong acid unites with an equally energetic base; but if, of the two constituents, one is more powerful than the other, then the reactions of that one are seen to a certain extent in the resulting salt. Thus the nitrate of iron reddens the vegetable color, because the oxide of iron, or *base* of the salt, is inferior in chemical energy to the nitric acid; and the carbonate of potash is *alkaline* to test-paper from a cause exactly the reverse; but if nitric acid and soda are brought together, then a *nitrate of soda* is produced which is *neutral* in every sense of the term.

The chloride of sodium and salts of a similar kind are freely soluble in water, but all salts are not so. Some dissolve only sparingly, and others not at all. The chloride and iodide of silver are examples of the latter class; they are not bitter and caustic like the nitrate of silver, but are perfectly tasteless, from being insoluble in the fluids of the mouth.

Therefore, it is seen from these examples, and many others which might be adduced, that the popular notion of a saline body is far from being correct, and that, in the language of strict definition, any substance is a salt which is produced by the union of an acid with an alkali, altogether independent of the properties it may possess.

Thus, *cyanide of potassium* is a true salt, although highly poisonous; nitrate of silver or *lunar caustic* is a salt; the blue sulphate of copper is a salt; so also is chalk or carbonate of lime, which has neither taste, color, nor smell.

The "Hydracid" Class of Salts. The distinction between oxyacids and hydracids has already been pointed out, the latter having been shown to consist of hydrogen united with elements analogous in their reactions to chlorine, iodine, bromine, etc. In a salt formed by an *oxygen* acid, both the basic and acid elements appear. Thus the common *nitre*, which is a nitrate of potash, is found by analysis to contain oxide of potassium as a base, in a state of combination with nitric acid. But if a salt is formed by neutralizing an alkali with a *hydrogen acid*, the product in that case does not contain all the elements. This is seen from the following example:

Hydrochloric Acid + Soda
= Chloride of Sodium + Water;

or, stated more at length,

(Chlorine Hydrogen) + (Oxygen Sodium)
= (Chlorine Sodium) + (Oxygen Hydrogen)

Observe that the hydrogen and oxygen, being present in the correct proportions, unite to form water, which is an oxide of hydrogen. This water passes off when the solution is evaporated, and leaves the dry crystals of salt. On the other hand, with

the oxyacid salts, the elementary hydrogen being absent, no water is formed, and the oxygen remains.

Therefore it must be borne in mind that salts like the chlorides, bromides, iodides, etc., contain only *two* elements, but that in the oxyacid salts, such as sulphates, nitrates, acetates, *three* are present. Thus nitrate of silver consists of nitrogen, oxygen, and silver, but chloride of silver contains simply chlorine and metallic silver united, without oxygen.

The Separated Hydrogen and Oxygen again Absorbed in the Decomposition of Hydracid Salts. If a portion of an hydracid salt—such, for instance, as the iodide of potassium—be dissolved in water, and a small quantity of oil of vitriol, or sulphuric acid, added, this oil of vitriol being very powerful in its chemical affinities, tends to destroy the existing salt and to appropriate to itself the base; but observe—it does not remove *potassium* and liberate *iodine*, but it takes the *oxide* of potassium and sets free *hydriodic acid*. In other words, as an atom of water is produced during the *formation* of an hydracid salt, so is an atom destroyed and made to yield up its elements in the *decomposition* of an hydracid salt.

The reaction of dilute sulphuric acid upon iodide of potassium may be stated thus:

Sulphuric acid *plus* (iodide of potassium) *plus* (hydrogen oxygen) *equals* (sulphuric acid, oxygen potassium) or sulphate of potash, *and* (hydrogen iodine) or hydriodic acid. —*Hardwich.*

Testing. Experiment to ascertain the strength or quality of a substance or instrument. (See *Hydrometer* and *Test-Papers.*)

Testing Collodion. This may be done by keeping constantly on hand a standard collodion, well secured from the air, and when the working sample is at fault compare its action in connection with the nitrate bath if the latter is in perfect working order, with the standard collodion.

Testing Lenses for Spherical Aberration. Point the camera at a very small bright object, such as the image of the sun reflected from a convex glass surface, and get it into the proper focus. Now move the lens to and fro, in order to throw the visual image on the ground-glass alternately within and without the focus; the bright point will expand into a luminous disk, and if it shows a firmer margin *within* than at an equal distance *without* the focus, it is under-corrected for spherical aberration, and slightly over-corrected for color, as all photographic lenses should be. If any color is visible it should be merely a slight fringe of blue within the focus or red without.

Testing the Nitrate Bath. (See *Nitrate Bath*, *Hydrometer*, and *Test-Papers.*)

Test-Papers. Chemically prepared papers used for the detection of acids or alkalies in solutions. Litmus and turmeric are the substances used in the manufacture of these papers; the former for acids and the latter for alkalies. Alkalies may also be detected by litmus-paper first reddened over fumes of acetic acid. The test-papers should be carefully kept in a dark place and protected from atmospheric air, or they soon become purple and useless. In such a case restore them by immersion in solution of liquor ammoniæ 1 drop to water 4 ounces. As the quantities tested for in photography are very small the papers should be in perfect condition. The mode of employing test-papers is as follows: Place a small strip in the liquid to be examined; if it becomes at once *bright red* a strong acid is present; but if it changes *slowly* to a *wine-red* tint a weak acid. In the case of the photographic nitrate bath faintly acidified with acetic acid a purple only may be expected, and a decided red color would suggest the presence of nitric acid. In the hypo fixing and toning bath which has acquired acidity the litmus paper will perhaps redden in about three or four minutes. In examining the nitrate bath for alkalinity with the reddened litmus paper, at least five or ten minutes should be allowed for the action, as the change of color takes place very slowly.

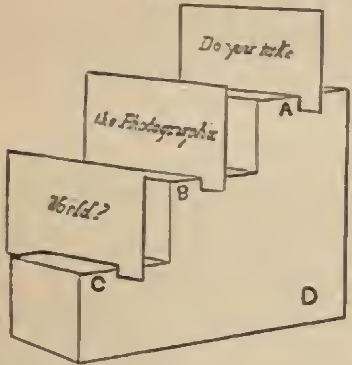
An alcoholic solution of phenol-phthaleïn 2:1000 may also be used. The latter becomes red in alkaline solutions, remaining colorless in neutral or acid liquids.

Test-Tube. A cylindrical tube made of very thin glass and open at one end, for heating solutions or liquids in which solid substances are to be dissolved.

Testing-Stand. Used for testing the correctness of lenses. *D* is a piece of board a foot long and six or eight inches wide, cut in this shape. *C B A* are three stout business cards placed in slots at right angles with the edge of the board, and the face of each card toward the letters in the diagram. For use place this in front of the camera at about

the distance required for an ordinary sitting, and focus on the middle card. The others will then be out of focus. Prepare and expose a straight plate; if the focus comes the

FIG. 217.



same as on the ground-glass everything is right, but if either of the other cards is sharper than *B*, then the ground-glass must be adjusted until it is found correct.

Tetrathionate. A salt composed of tetrathionic acid and a base. The bodies which produce tetrathionate when added to a solution of hyposulphite of soda, and hence are inadmissible in the toning process, are as follows: Free iodine, perchloride of iron, chloride of copper, acids of all kinds (in the latter case the acid first produces sulphurous acid, and the sulphurous acid, if present in any quantity, by reacting upon the hyposulphite of soda forms tetrathionate and trithionate of soda). Chloride of gold also produces a mixed tetrathionate of gold and soda when added to the fixing-bath; but as the quantity of chlorine used is small the action is less sensible. Tetrathionates in the toning and fixing baths produce sulphurization, and consequently destruction of the print; their presence, therefore, should be carefully guarded against.

Tetrathionic Acid. This acid is formed by the union of 5 atoms of oxygen with 4 of sulphur; it is a very unstable salt, and uniting, as it often does, with the hypo in the toning-bath, produces tetrathionate of soda, a salt very active in the coloration of the photographic print, but very influential in its subsequent destruction.

Thermograph. The proof produced by thermography.

Thermography. A process founded upon the heat radiations—associated with the chemical actions of the color rays—discovered by Mr. Hunt. The principles and practice of this discovery he thus sums up:

"All bodies radiate light even in complete darkness. This light does not appear to be allied to phosphorescence, for there is no difference to be perceived whether the bodies have been long in the dark, or whether they have been just exposed to daylight, or even to direct solar light. Two bodies constantly impress their images on each other, even in complete darkness. However, for the image to be appreciable, it is necessary, because of the divergence of the rays, that the distance of the bodies should not be very considerable. To render the image visible, the vapor of water, mercury, iodine, etc., may be used. There exists *latent light* as well as latent heat. Having instituted a series of experiments, the results of which appear to prove that these phenomena are not produced by *latent light*, I am desirous of recording them. I would not be understood as denying the absorption of light by bodies; of this I think we have abundant proof, and it is a matter well deserving attention. If we pluck a nasturtium when the sun is shining brightly on the flower, and carry it into a dark room, we shall still be enabled to see it by the light which it emits. The human hand will sometimes exhibit the same phenomenon, and many other instances might be adduced in proof of the absorption of light, and I believe, indeed, of the principle that light is latent in bodies. I have only to show that the conclusions of M. Moser have been formed somewhat hastily, he being led, no doubt, by the striking similarity which exists between the effects produced on the daguerrotype plate under the influence of light and by the juxtaposition of bodies in the dark, to consider them as the work of the same element.

"Dr. Draper, in the *Philosophical Magazine* for September, 1840, mentions a fact which has been long known; that is: 'If a piece of very *cold* clear glass, or what is better, a *cold* polished metallic reflector, has a little object, such as a piece of metal, laid on it, and the surface be breathed over once, the object being then carefully removed, as

often as you breathe on it again a spectral image of it may be seen; and this phenomenon may be exhibited for many days after the first trial is made.' Several other similar experiments are mentioned, all of them going to show that some mysterious molecular change has taken place on the metallic surface, which occasions it to condense vapors unequally. On repeating this simple experiment I find that it is necessary for the production of a good effect to use dissimilar metals; for instance, a piece of gold or platina on a plate of copper or of silver will make a very decided image, whereas copper or silver on their respective plates gives but a very faint one, and bodies which are bad conductors of heat, placed on good conductors, make decidedly the strongest impressions when thus treated. I placed upon a well-polished copper plate a sovereign, a shilling, a large silver medal, and a penny. The plate was gently warmed, by passing a spirit-lamp along its under surface; when cold, the plate was exposed to the vapor of mercury; each piece had made its impression, but those made by the gold and the large medal were more distinct; not only was the disk marked, but the lettering on each was copied. A bronze medal was supported upon slips of wood, placed on the copper, one-eighth of an inch above the plate. After mercurialization the space the medal covered was well marked, and, for a considerable distance around, the mercury was unequally deposited, giving a shaded border to the image; the spaces touched by the mercury were thickly covered with the vapor. The above coins and medals were all placed on the plate, and it was made too hot to be handled, and allowed to cool without their being removed; impressions were made on the plate in the following order of intensity: gold, silver, bronze, copper. The mass of the metal was found to materially influence the result, a large piece of copper making a better image than a small piece of silver. When this plate was exposed to vapor it was found that the gold and silver had made permanent impressions on the copper. The above being repeated with a still greater heat, the image of the copper coin was, as well as the others, most faithfully given, but the gold and silver only made permanent impressions. A *silvered* copper plate was now tried with a moderate warmth. Mercurial vapors brought out good images of the gold and copper; the silver marked, but not well defined. Having repeated the above experiments many times with the same results, I was desirous of ascertaining if electricty had any similar effect; powerful discharges were passed through and over the plate disks, and it was subjected to a long-continued current, without any effect. The silver having been cleansed off from the plate, it was now warmed with the coins and medals upon it, and submitted to discharges from a very large Leyden jar; on exposing it to mercurial vapor the impressions were very prettily brought out, and, strange to say, spectral images of those which had been received on the plate when it was silvered. Thus it was proved that the influence, whatever it may be, was exerted to some depth in the metal.

"I placed upon a piece of copper, blue-, red-, and orange-colored glasses, pieces of flint glass, mica, and a square of tracing-paper. These were allowed to remain in contact half an hour. The space occupied by the red glass was well marked; that covered by the orange was less distinct, but the blue glass left no impression; the shapes of the flint and crown glass were well made out, and a remarkably strong impression where the crown glass rested on the tracing-paper, but the mica had not made any impression. The last experiment I repeated. After the exposure to mercurial vapor, heat was again applied to dissipate it; the impression still remained. The experiment was repeated, but the vapor of iodine was used instead of that of mercury. The impressions of the glasses appeared in the same order as before, but also a very beautiful image of the mica was developed, and the paper was well marked out, showing some relation to exist between the substances used and the vapors applied. I placed the glass used above with a piece of well-smoked glass, for half an hour, one-twelfth of an inch below a polished plate of copper. The vapor of mercury brought out the image of smoked glass only. All these glasses were placed on the copper, and slightly warmed; red and smoked glasses gave, after vaporization, equally distinct images, the orange the next, the others left but faint marks of their forms; polishing with tripoli and putty powder would not remove the images of the smoked and red glasses. An etching, made upon a smoked etching-ground on glass, the copper and

glass being placed in contact; the image of the glass only could be brought out. A design cut out in paper was pressed close to a copper plate by a piece of glass, and then exposed to gentle heat; the impression was brought out by the vapor of mercury in beautiful distinctness. On endeavoring to rub off the vapor, it was found that all those parts which the paper covered amalgamated with mercury, which was rubbed from the rest of the plates; hence there resulted a perfectly white picture on a polished copper plate. The colored glasses before named were placed on a plate of copper, with a thick piece of charcoal, a copper coin, the mica, and the paper, and exposed to fervent sunshine. Mercurial vapor then brought up the images in the following order: smoked glass, crown glass, red glass, mica beautifully delineated, orange glass, paper, charcoal, the coin, blue glass; thus distinctly proving that the only rays which had any influence on the metal were the calorific rays. The experiment was repeated on different metals, and with various materials, the plate being exposed to steam and iodine. I invariably found that those which absorbed or permitted the permeation of the most heat gave the best images. The blue and violet rays could not be detected to leave any evidence of action, and, as spectra imprinted on photographic papers by light which had permeated these glasses gave evidence of the large quantity of the invisible rays which passed them freely, we may also consider those as entirely without the power of effecting any change on compact, simple bodies.

"In a paper which I published in the *Philosophical Magazine* for October, 1840, I mentioned some instances in which I had copied printed paper and engravings on iodized paper by mere contact and exposure to the influence of calorific rays or to artificial heat. I then, speculating on the probability of our being enabled, by some such process as the one I then named, to copy pictures and the like, proposed the name of *Thermography*, to distinguish it from photography. I now tried the effects of a print in close contact with a well-polished copper plate. When exposed to mercury I found that the outline was very faithfully copied on the metal. A paper ornament was pressed between two plates of glass and warmed; the impression was brought out with tolerable distinctness on the under and warmest glass, but scarcely traceable on the other. Rose leaves were faithfully copied on a piece of tin plate exposed to the full influence of sunshine; but a much better impression was obtained by a prolonged exposure in the dark. With a view of ascertaining the distance at which bodies might be copied I placed upon a plate of polished copper a thick piece of plate-glass, over this a square of metal, and several other things, each being larger than the body beneath. These were all covered by a deal box, which was more than half an inch distant from the plate. Things were left in this position for a night.

"On exposing to the vapor of mercury, it was found that each article was copied, the bottom of the deal box more faithfully than any of the others, the grain of the wood being imaged on the plate. Having found, by a series of experiments, that a blackened paper made a stronger image than a white one, I very anxiously tried to effect the copying of a printed page or a print. I was partially successful on several metals; but it was not until I used copper plates amalgamated on one surface, and the mercury brought to a very high polish, that I produced anything of good promise. By carefully preparing the amalgamated surface of the copper, I was at length enabled to copy from paper, line-engravings, woodcuts, and lithographs, with surprising accuracy. The first specimens produced exhibited a minuteness of detail and sharpness of outline quite equal to the early daguerrotypes and the photographic copies prepared with the chloride of silver. The following is the process adopted by me, which I consider far from perfect, but which affords us very delicate images:

"A well-polished plate of copper is rubbed over with the nitrate of mercury, and then well washed to remove any nitrate of copper which may be formed; when quite dry, a little mercury taken up on soft leather or linen is well rubbed over it, and the surface worked to a perfect mirror. The sheet to be copied is placed smoothly over the mercurial surface, and a sheet or two of soft clean paper being placed upon it, is pressed into equal contact with the metal by a piece of glass, or flat board; in this state it is allowed to remain for an hour or two. The time may be considerably shortened by applying

a very gentle heat for a few minutes to the under surface of the plate. The heat must on no account be so great as to volatilize the mercury. The next process is to place the plate of metal in a closed box, prepared for generating the vapor of mercury. The vapor is to be slowly evolved, and in a few seconds the picture will begin to appear; the vapor of mercury attacks those parts which correspond to the white parts of the printed page or engraving, and gives a very faithful but somewhat indistinct image. The plate is now removed from the mercurial box, and placed into one containing iodine, to the vapor of which it is exposed for a short time; it will soon be very evident that the iodine vapor attacks those parts which are free from mercurial vapor, blackening them. Hence there results a perfectly black picture, contrasted with the gray ground formed by the mercurial vapor.

"The picture being formed by the vapors of mercury and iodine, is of course in the same state as a daguerrotype picture, and is readily destroyed by rubbing. From the depth to which I find the impression made in the metal, I confidently hope to be enabled to give to these singular and beautiful productions a considerable degree of permanence so that they may be used by engravers for working on. It is a curious fact that the vapors of mercury and of iodine attack the plate differently; and I believe it will be found that vapors have some distinct relation to the chemical or thermo-electrical state of the bodies upon which they are received.

"Moser has observed this, and attributes the phenomena to the colors of the rays, which he supposes to become latent in the vapor on its passing from the solid into the more subtile form. I do not, however, think this explanation will agree with the results of experiments. I feel convinced that we have to do with some thermic influence, and that it will eventually be found that, purely, some calorific excitement produces a molecular change, or that a thermo-electric action is induced which effects some change in the polarities of the ultimate atoms of the solid. These are matters which can only be decided by a series of well-conducted experiments; and, although the subject will not be laid aside by me, I hope the few curious and certainly important facts which I have brought before you will elicit the attention of those whose leisure and well-known experimental talents qualify them in the highest degree for the interesting research into the action of those secret agents which exert so powerful an influence over the laws of the material creation.

"Although attention was called to the singular manner in which vapors disposed themselves on plates of glass and copper, by Dr. Draper, and about the same time to the calorific powers of the solar spectrum, by Sir John Herschel, and to the influence of heat artificially applied, by myself, yet it is certainly due to M. Moser, of Königsberg, to acknowledge him to be the first who has forcibly called the attention of the scientific world to an inquiry which promises to be as important in its results as the discovery of the electro-pile by Volta. As to the practical utility of this discovery, when we reflect on the astonishing progress made in the art of photography since Mr. Fox Talbot published his first process, what may we not expect from thermography, the first rude specimens of which exhibit far greater perfection than the early efforts of the sister art? As a subject of purely scientific interest, thermography promises to develop some of those secret influences which operate in the mysterious arrangements of the atomic constituents of matter, to show us the road into the yet hidden recesses of Nature's works, and enable us to pierce the mist which at present envelops some of the most striking phenomena which the penetration and industry of a few 'chosen minds' have brought before our obscured visions. In connection with photography, it has made us acquainted with subtile agencies working slowly but surely, and indicated physical powers beyond those which are already known to us, which may possibly belong to a more exalted class of elements, or powers, to which light, heat, and electricity are subsidiary in the great phenomena of Nature."

Since the publication of Mr. Hunt on this process many experiments have been made which give it new interest and add some steps to its progress toward practical application. From these experiments we select some of the most important by M. Niépce de St. Victor:

"If, upon a metal plate heated in contact with boiling water, we place first an engraving, then a sheet of paper impregnated first with nitrate of silver and afterward with

chloride of gold, we obtain a violet-blue image of the blacks of the engraving. If the paper is only impregnated with the nitrate, the whites only of the engraving are reproduced in a bistre color. If we place a paper printed with large letters between two plates of glass and heat the whole to a temperature just sufficient to slightly scorch the paper, upon removing the paper we find that the letters have left their imprint upon the glass. If upon this imprint we place a sheet of paper prepared with the salts of silver and gold, and warm the whole on a metal plate, heated with boiling water, we obtain a new image, as if the sensitive paper had been placed upon the printed characters themselves. An unvarnished positive photographic image upon collodionized glass, formed by reduced iodide of silver, has, under the influence of heat, printed on sensitized paper many consecutive images of the "darks," the last proof being the sharpest and most vigorous. Some glazed tiles and porcelain plates with black letters or painted in various colors, and passed through the furnace without being enamelled, gave impressions; but letters and designs covered with enamel gave none. Tissues shaded with black and white, or with varied colors, impressed their images on sensitized paper; but the images were very variable.

"Prepare two solutions, one of fused nitrate of silver, of the strength of 1 per cent., the other of chloride of gold of the same strength. Float a sheet of paper upon the silver solution and dry it slowly, without scorching, before a fire; when dry pass it through the solution of gold, floating the same side that was placed on the silver solution; dry it again without the temperature attaining that of boiling water, because at this temperature the paper becomes discolored. To obtain an image on this paper, place an engraving with its back upon a plate of glass or metal warmed by boiling water, and lay the sensitized paper upon the engraved side, and cover it with a plate of glass about ¼ of an inch thick; upon looking through this glass you will see the image appear in a few minutes. The image is clearest when the paper is very dry and not over-sensitive; if it does not become sufficiently distinct it may be strengthened by exposing the sheet to the heat of a clear fire. If it be very vigorous, and stands out clearly from the ground slightly colored, it may be fixed by treating it with a solution of hyposulphite of soda. The paper sensitized with the double salt of silver and gold will not keep in the dark; it must be prepared as wanted, and used immediately."

Thermometer. An instrument which determines and records changes of temperature in the atmosphere, liquids, gases, and substances. Various scales of division of temperature are used, and it is important to the photographer to be able to harmonize those in general use. The three principal scales are those called Fahrenheit, used in America and England; centigrade, used in France; and Réaumur, used in a few other countries. Of these, Fahrenheit's scale is the most commonly used. To convert the centigrade scale to Fahrenheit, multiply the number given by 9, divide by 5, and add 32. To convert Réaumur to Fahrenheit, multiply the number given by 9, divide by 4, and add 32. To convert Fahrenheit to centigrade, subtract 32, multiply by 5, and divide by 9. To convert Fahrenheit to Réaumur, subtract 32, multiply by 4, and divide by 9. To convert Réaumur to centigrade, multiply by 5, and divide by 4. To convert centigrade to Réaumur, multiply by 4, and divide by 5. The abbreviations generally used to denote these three scales are F., or Fahr., for Fahrenheit; C., or Cent., for centigrade; and R. for Réaumur.

Thiocarbamid-Hauff. This is a new preparation for use with the fixing-bath to prevent discoloration of the plates or papers used. Dr. J. M. Eder reports as follows:

"Thiocarbamid possesses the property (when added to the fixing-bath) of preventing bromide of silver gelatine plates, as well as chloride of silver gelatine plates and bromide of silver gelatine papers, from coloring the gelatine layer yellow, and prevents the formation of so-called green fog.

"The preparation consists of white crystals and gives in water a colorless liquid. I find that it acts (in acid solutions) as a preventive against yellowish negatives.

"I made a solution of

Thiocarbamid	10 parts.
Citric Acid or Sulphuric Acid	10 "
Water	1000 "

I immersed in this solution a pyro negative strongly colored with green fog, and after a short time the yellowish-green color had disappeared. With amidol I was not able to

obtain negatives showing green fog, and therefore could not make a trial. If the salt is added to the fixing-bath it prevents the formation of green fog with plates and bromide of silver paper; but it must be observed that the bath should be *acid*.

"For fixing I found the following formula very useful:

Water	1000 parts.
Fixing Soda	200 "
Thiocarbamid	10-15 "

To this solution is added fifty parts of bisulphate of soda.

"I would observe that plates as well as papers before fixing must be washed sufficiently so as to remove all traces of the developer.

"As the action of thiocarbamid in the fixing-bath is only of proportionately short duration, it is recommended to use an ordinary acid fixing-bath, which, as is known, will by itself prevent to a certain extent the formation of green fog; and after the use of this, if necessary, the above discoloring bath can be applied, and this will become necessary, especially for certain kinds of bromide of silver gelatine paper."

Thiocarbamide. The compound salt tetrathiocarbamide-ammonium, containing 4 molecules of thiocarbamide and 1 molecule ammonium bromide, has been suggested as a means of reversing the negative image in development. (See *Reversal of the Image.*)

Thiosinamine. A crystalline substance obtained by the addition of ammonia to pure oil of mustard, which is then filtered and evaporated. Suggested by Waterhouse as a means of reversing the negative image (obtaining a positive) in development. (See *Reversal of the Image.*)

Thiosulphates. Some acids contain sulphur in place of oxygen. In recent times these acids are distinguished by the prefix *thio* (Greek for sulphur), so that we now speak of *thiosulphuric* instead of hyposulphurous acid. So also, sodium hyposulphite is properly called *sodium thiosulphate*, being a salt of thiosulphuric acid, although the term hypo soda is still commonly used. Acids decompose "hypo," liberating free sulphur, which is injurious to photographic plates or prints. Hence, the hypo bath should always be kept neutral or slightly alkaline.—*Harrison.*

(See APPENDIX—*Walpole.*)

Time Exposures. Dry plates which have been exposed more than a fraction of a second (in contradistinction to instantaneous exposures).

Tin. Tin is a white metal possessing a silvery lustre; it is very malleable, but not so ductile and tenacious as many other metals; it is soft, fuses at 442° F., and has a specific gravity of 7.9. When tin is heated to whiteness it takes fire, burns with a white flame, and is converted into the protoxide of tin. Tin of commerce is nearly pure, containing, however, sometimes, traces of iron, copper, and arsenic; it is obtained from the native oxide by exposure to heat in combination with charcoal. Its equivalent = 58.

Tin, Chloride of. (See *Muriate of Tin.*)

Tin, Iodide of. A compound made by adding a solution of hydriodate of potassa to a proto-salt of tin in solution. Or, heat together 2 parts of granulated tin and 5 parts of iodine.

Tin, Oxide of. *Protoxide* of tin is made by precipitating a solution of chloride of tin by carbonate of potassa; well wash and dry at a heat of 196° F. unexposed to air. *Peroxide* is made by the action of nitric acid on metallic tin. Well wash the precipitate with water, and dry. *Sesquioxide* is made by mixing fresh moist hydrated peroxide of tin with a solution of the neutral protochloride.

Tincal. The name given to a variety of borax occurring naturally in Ladok and Great Thibet, in Asia. In a refined form tincal is sold as Indian borax.

Tincture. The finer or more volatile parts of a substance separated by a solvent, or an extract of a part of the substance of a body communicated to the solvent. A spirituous solution of such of the approximate principles of vegetables and animals as are soluble in pure alcohol or proof spirits.

Tint. A color weakened by admixture with white.

Tinted Glass. Glass slightly colored with any hue.

Tithnotype. A process discovered by Dr. Draper, of New York, for copying the surface of daguerrotypes in copper by the electrotype, after it has been fixed by gilding. Tithnotypes may also be obtained by means of a coating of gelatine. 2. The copy in copper of the daguerrotype so produced. These beautiful tithnotypes are produced in the following way: The daguerrotype plate is carefully gilded, taking care that the film of

gold is neither too thick nor too thin. The proper thickness is readily attained after a little practice. The plate is then kept a day or two, so that it may become enfilmed with air. The back and edges being varnished, copper is to be deposited upon it by the usual electrotype process, the process occupying from twelve to twenty hours. If the plate has been properly gilded, and the process conducted successfully, the tithnotype readily splits off the daguerrotype. The reader will understand that when the process succeeds the daguerrotype will be uninjured, and the tithnotype a perfect copy of it. If any portions are blue or white, or flesh-colored, they will be seen in the same colors in the tithnotype; the intensity of light and shade is also given with accuracy, and, indeed, the copy in all respects of the original. A great advantage is also obtained in the reversal that takes place; the right side of the tithnotype corresponds to the right side of the original object, and the left to the left. In the daguerrotype it is not so. There is no difficulty in obtaining from these tithnotypes duplicate copies. An expert artist can multiply them one from another. Mr. Endicott, a lithographic artist of distinction, of New York, was the first to make these pictures.

Tithonicity. The term proposed by Dr. Draper for that property of light which is the source of all photographic effects, and which is now universally known as actinism. (See *Actinism.*)

Titles on Negatives and Prints. The simplest way in which to title a print is to write the name backward on the negative, using any opaque liquid, such as Indian ink, for that purpose. If this is done at a corner of the negative where there is a shadow, the title will appear in white letters upon the print. Another way is to write the title on the paper before printing, using Indian ink for this also. This ink will wash off in the after-treatment, and leave the title in white lettering. Another way is to print the titles on "French folio post" clear paper covered with varnish and attach them to the plates.

Tone. The harmonious relation of the colors of a picture in light and shade. The term is often used to qualify, or as synonymous with *depth, richness,* and *splendor* in pictures. It has been also more recently used to denote the characteristic expression of a picture, as distinguished by its color.

To Beat to a Froth. To whip albumen in a platter into a stiff foam with a broom or beater.

To Clear. To render discolored silver baths clear again, by the addition (and agitation) of kaolin or permanganate of potash, and subsequent filtration.

To Desensitize. To make light-sensitive substances not sensitive to light, by certain additions (for instance, bromide of silver by bichromate of potash).

To Oxidize. To combine oxygen with a body. Many bodies oxidize of themselves, by the oxygen in the air—for instance, alcohol and ether, which become transformed into acetic acid, sulphate of iron, which slowly transforms into the brown-yellow ferric sulphate, etc.

To Set. To allow to set; causing a gelatine solution or film to thicken by cooling.

Toluin. $C_6H_5CH_3$. A component of gas-tar; liquid, volatile, resembling benzene in smell and in other qualities. It is soluble in alcohol, ether, and bisulphuret of carbon. Used in the production of coloring matter, as also of retouching varnish.

Tongs Finger-Protector. Bend a stout wire (thickness depending upon size of plate to be held) into the shape of the letter U (inverted), spreading the lower part of the prongs as shown in the cut. Next, bend two thin and flat pieces of metal so that, when a plate is inserted between the jaws or feet of the "tongs," the surface of the plate and that of the feet will coincide. Solder the sides of these feet to the ends of the wire, and having placed a plate in position, slip a stout band of rubber down until the tension is strong enough to grasp the plate firmly. The readiness with which a plate can be lifted for examination and placed in the developer is self-evident on a glance at the cut.

FIG. 218.

Toning. The chemical coloration of the photographic positive proof upon paper. This is effected by the *toning-bath.* The tendency of the toning process is to darken the color of the print, the tint or color being varied by the nature of the toning-bath and

the methods of preparing the paper for the pressure-frame. Highly salted and sensitized paper usually gives darker pictures than those containing less chloride of silver, and in the toning-bath the former will yield a black print under the same circumstances in which the latter gives a brown or sepia color. The same effects are produced, in the first case, by sizing the paper with rice glue, and in the second, with gelatine, using in both instances a silver solution of medium strength. The salts of gold in the toning-bath have a tendency to impart a bluish-black color to the print, which may be modified to a gray by the addition of a salt of lead; or to a brown of any tint, from sepia to an amber, by adding ammonia or carbonate of soda. Where the toning and fixing are effected separately, considerable allowance must be made in printing for loss of strength and color in the fixing-bath. The darker the color required, the more the print should be "over-printed," *within the bounds of perfect definition*. When the toning and fixing baths are combined the "over-printing" should be slight, but in proportion to the strength of hyposulphite in the bath. The color can also be modified by soaking the print in a solution of common salt before toning. The age of the bath has considerable effect in strengthening the color, although it works slower and renders the print more liable to fade; this last effect, however, can be remedied by frequent filtration, provided the gold is not exhausted and the toning entirely effected by the sulphuretting compound formed in the bath. (See *Tetrathionate*.) Acetic acid added to the toning-bath produces the most beautiful black prints, but its addition has been altogether abandoned, from a supposition that it tends to the destruction of the print, by forming tetrathionate of soda, a very unstable salt; but experience has shown that this does not always take place and can be avoided by using proper proportions and not employing the bath for too long a time. Care in the use of all these substances must, of course, guide the photographer.

In toning, the temperature of the bath should be strictly attended to, and it should be kept as near 70°, both winter and summer, as possible. The manipulations in toning are very simple, and as many prints can be toned at once as the bath will float free from the bottom and from each other; but in putting them into the bath it is necessary to completely immerse them at once, and in such a manner as to prevent the formation of bubbles upon the face of the print, otherwise spots of a shade lighter than the pervading color will be produced. (For toning transparencies see *Transparencies*.) For toning images on opaque supports, such as paper, the formulæ differ according to the nature of the sensitive surface used. (See INDEX; *Coloration of Photographic Prints*; *Fixing*; *Permanence*, and *Toning-Bath*.)

The following are some of the standard formulæ advised in the various processes in common use:

For Prints on Plain Salted Paper.

Tungstate of Soda	20 grains.
Phosphate of Soda	20 grains.
Boiling Water	3 ounces.

Dissolve and add:

Gold Terchloride	1 grain.

Allow to cool, and add:

Water	5 ounces.

Combined Toning and Fixing Bath for Plain Paper.

Water	24 ounces.
Hypo Soda	6 "
Sulphocyanide of Ammonium	1 ounce
Sat. sol. of Potash Alum	2 ounces.

Dissolve; place in this some scraps of gelatino-chloride paper for twenty-four hours; filter, and add:

Water	6 ounces.
Gold Terchloride	15 grains.
Ammonium Chloride	30 grains.

Platinum Bath for Plain Paper.

Platinum Perchloride	1 grain.
Water	16 ounces.
Carbonate of Potash, sufficient to neutralize.	
Formic Acid	½ to 1 drachm.

(See also *Uranium*.)

Acetate Bath for Albumenized Paper.

Chloride of Gold	1 grain.
Acetate of Soda	30 grains.
Distilled Water	10 ounces.

Neutralize the gold with a little chalk solution, allow to settle and add to the acetate dissolved in the water. This bath works best when old.

Borax Bath.

Borax	70 grains.
Gold Chloride	1 grain.
Water	20 ounces.

Tungstate Bath.

Tungstate of Soda	20 grains.
Gold Chloride	1 grain.
Water	10 ounces.

Chloride of Calcium Bath.

Gold Chloride	2 grains.
Calcium Chloride	2 "
Powdered Chalk	1 teaspoonful.
Water	16 ounces.

This bath works best when not too fresh.

Platinum Bath.

Platinum Perchloride	1 grain.
Water	16 ounces.

Neutralize with potassium carbonate, and then add ½ drachm of formic acid. This bath is also suitable for plain salted papers.

Formula for Black Tones.

Water	32 ounces.
Sodium Acetate	60 grains.
Sodium Chloride	60 "
Uranium Nitrate	4 "
Gold Chloride	4 "

Bicarbonate of Soda Bath.

Chloride of Gold	1 grain.
Bicarbonate of Soda	80 grains.
Distilled Water	10 ounces.

This bath gives warm tones. It should be used as soon as made.

Warm Tones on Bromide Paper. After development immerse in the following:

Potassium Ferricyanide (not Ferrocyanide)	9 grains.
Uranium Nitrate	8 "
Glacial Acetic Acid	5 drachms.
Water	16 ounces.

Dissolve the ferricyanide in the water and let stand a few minutes, add the acetic acid, then the uranium nitrate; filter if any precipitate is formed.

This toning solution will keep for about three days—it may be used to tone about twenty prints of almost any size. If any precipitate forms during the operation, filter it off, as it will discolor the print.

Tone to the desired color and wash in running water for about twenty-five minutes or until the print is clear and free from yellow color. The secret of success lies in washing the print free from hypo and iron before toning.

The toning solution acts slightly as an intensifier, and the best success is attained with prints from thin negatives.

The permanency of the picture is not believed to be impaired by the above process.

Dr. Stolze, of Berlin, recommends for the obtaining of brown tones on bromide paper a process for re-development. For the first development he uses:

A. Sodium Sulphite	10 parts.
Eikonogen	2 "
Distilled Water	150 "
B. Carbonate of Potash	25 "
Distilled Water	150 "

For use, mix 25 parts No. 1 with 10 parts No. 2, and add 75 parts distilled water. The print is then bleached in a solution made up as follows:

A. Sulphate of Copper	1 part.
Distilled Water	100 parts.
B. Potassium Bromide	1 part.
Distilled Water	100 parts.

These are mixed, and the prints bleached therein, then thoroughly washed, after which they are re-developed with the following:

Solution No. 1	50 parts.
Solution No. 2	20 "
Distilled Water	1930 "

Toning is stopped by immersion in a bath of citric acid, 1 to 100 of water.

Formula for Prints on Japanese Paper.

Chloro-platinite of Potassium	15 grains.
Citric Acid	50 "
Water	25 ounces.

This bath should be mixed 48 hours before use.

To Give a Black Tone to Ferro-Prussiate Prints. The print is washed in water slightly acidulated with nitric acid. It is then immersed in the following bath:

Carbonate of Soda	20 parts.
Water	500 "

until the disappearance of the image and its reappearance with an orange tone. It is then passed into a bath composed of

Gallic Acid	20 parts.
Water	500 "

The image becomes black. It is then put in water acidulated with hydrochloric acid, and afterward washed in abundant water.

Toning-Baths for Collodio-Chloride Paper.

Warm Water	1000 parts.
Powdered Chalk	8 "
Solution of Gold at 10 per cent.	60 "

Another.

Chloride of Gold	15 grains.
Water	5 ounces.

Neutralize with lime-water, make up to 15 ounces with water, and add 2 drachms chloride of calcium. This stock solution should be diluted with ten times its bulk of water for use.

Toning-Baths for Gelatino-Chloride Paper. When cold tones are desired use a strong bath as given below; when warmer tones are desired dilute the bath with water:

Gold Bath.

Water	64 ounces.
Saturated Solution of Borax .	¼ ounce.
Saturated Solution of Acetate of Soda	1 drachm.

Add gold in solution slowly; sufficient to tone (1 grain of gold will tone 20 to 30 cabinet prints). Now test with litmus-paper, and add citric acid (saturated solution) drop by drop to *almost neutralize the bath, keeping same slightly alkaline.* The borax and acetate of soda in above bath may be substituted with 1 drachm of saturated solution of phosphate of soda.

Another.

1. Chloride of Gold	15 grains.
Water	10 ounces.
2. Borax, saturated Solution.	

For Toning.

Water	20 ounces.
No. 1	1 ounce.
No. 2 . . .	sufficient to neutralize.

Combined Toning and Fixing Baths.—Liesegang's Combined Toning-Bath:

Water	24 ounces.
Hyposulphite of Soda . .	6 "
Sulphocyanide of Ammonium .	1 ounce.
Acetate of Soda	1½ ounces.
Saturated Solution of Alum .	10 "

Fill the bottle containing this solution with scraps of sensitized paper and leave it for a day. Then filter and add the following solution:

Water	6 ounces.
Chloride of Gold	15 grains.
Chloride of Aluminium . . .	30 "

Burton's Combined Bath.

Hyposulphite of Soda	4 ounces.
Chloride of Gold	6 grains.
Water	1 pint.

The prints are put direct into this solution dry. They instantly turn yellowish-red, but gradually turn to a warm red, and eventually to a brown. If they are removed whilst yet red the color, on drying, will be a splendid purple-brown. If they are allowed to get brown, the eventual color will be an engraving black. The purity of the whites is wonderful, and *there is no loss of half-tone unless the process is carried too far.*

Wolf's Combined Bath for Aristo Paper.

Water	20 ounces.
Hypo Soda	4 "
Sulphocyanide of Ammonium .	½ ounce.
Lead Acetate	60 grains.
Lead Nitrate	60 "
Gold Chloride (neutral) . .	4 "

The substances are to be dissolved in the order named, and the bath allowed to clear and settle. Prints for this bath do not require previous washing, and if desired may be fixed separately in a hypo bath of 10 per cent. strength.

Toning and Fixing in One Bath.

Chloride of Gold	1 grain.
Phosphate of Soda . . .	15 grains.
Sulphocyanide of Ammonium .	25 "
Hyposulphite of Soda . . .	240 "
Water	2 ounces.

Dissolve the gold in a small quantity of water, and add it to the other solution.

Toning with Palladium. Duchochois recommends the following formula for silver prints:

Palladium Chloride	1 part.
Sodium Chloride	1 "
Distilled Water	100 parts.

If the solution is not clear or a precipitate is formed, the liquid should be heated in a porcelain dish until clear. Ten parts of acetic acid and 400 parts of water are then added, when a yellow-brown solution is obtained, which tones the prints black as with platinum. The yellow tinge of the prints so toned can be removed by immersion in a 5 per cent. solution of ammonia.

Toning with Iridium. This metal gives violet tones, like those obtained by the use of gold. Take

Neutral Sodium Tartrate . .	15 part.
Chloride of Iridium and Potassium	1½ parts.
Distilled Water	100 "

Boil for two minutes, then add 400 parts of distilled water and 10 parts of acetic acid.

Toning with Osmium. Take

Yellow Chloride of Osmium and Ammonium	1 part.
Sodium Chloride	1 20 part.
Sodium Succinate	4 parts.
Water	1000 parts.

Prints toned in this bath assume first a burnt-sienna tone, changing to an intense azure tint with pure whites.

Toning with Aluminium. Take

Aluminium Chloride	20 grains.
Sodium Bicarbonate	85 "
Water	12 ounces.

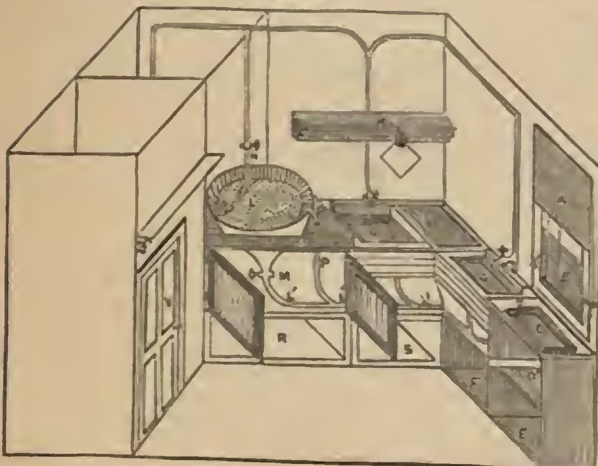
Dissolve, allow to stand a little time, and filter; then add (at each toning) 1 grain chloride of gold for every sheet of paper to be toned.

Toning with Uranium. (See *Uranium.*)

Toning-Bath. The solution in which is effected the coloration of the photographic print before fixation. For making toning-baths the formulas are very numerous, and for each some peculiar quality is claimed. In all cases where hyposulphite is used in the toning-bath, the gold must be dissolved separately and poured into the other solution, otherwise the gold will be precipitated. It must also be remembered that albumen and plain prints cannot be toned in the same bath with good results, or without endangering their permanence.

Toning and Washing Room. Used by photographic printers for finishing positives.

FIG. 219.



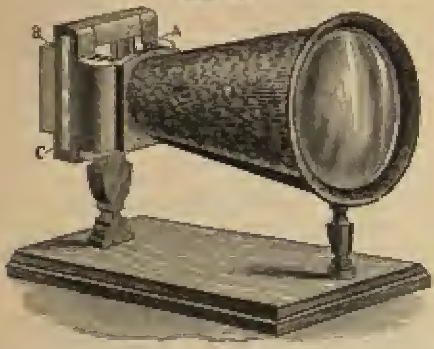
A is a dark curtain to raise and lower; *B*, a second curtain for the same purpose; *C*, the shelf where the toning is done; *D*, the silvering dish, and *D'* a place for the dish when not in use. *E* is where a kettle of potash is kept for cleansing old plates; *F*, for the nitric acid tray; *G G*, sinks; *H*, shelf for toning-bottles; *K*, a rack with spring clips to hold pictures while draining; *L*, a washing-tank with perforated false bottom; *L'*, the waste-pipe. A stopcock, *M*, is adjusted after the tank becomes full so that it will permit the water to flow out as rapidly as it enters through the pipe, *N*. *P P* is an overflow pipe connecting with the waste-pipe, *L'*; *R* is the place for the fixing-dish; *S*, the place for the bottle of hypo solution; *V* is a door which leads into the drying-room.

Touching-Out. Removing accidental spots or imperfections in the negatives or positives. The tint for this purpose should always assimilate as nearly as possible to that of the photograph. Many use India-ink only for the purpose, without the slightest reference to the tone of the picture, and so render the defects as palpable as ever, if not more so. A few of the mixtures which may be used for the purpose are as follows: India-ink and madder brown; lake, lamp-black, and indigo; sepia, indigo, and lake; burnt sienna, lake, indigo, and sepia; Vandyke brown and lake. For albumenized prints use a little gum-water with the color. The pencil must not be too full of color, and the method most successful is that of stippling with the point of a small sable pencil. As it is very difficult to touch out dark spots in the positive, the transparent spots or stains in the *negative* should be touched out with opaque water color in order that they may print white in the positive. For this purpose we may use cadmium yellow, which is best applied after varnishing, as there is no risk of injuring the film.

Tourescope. An apparatus invented by Edward L. Wilson for viewing lantern slides and other transparencies. It consists of a condensing lens

and a tube leading to the frame, *A*. In the slots of the latter the transparencies are placed. The effect of enlargement is pleasingly secured in this way. Another slot at

FIG. 220.



E is for larger pictures, such as are mounted in wooden frames. At *C* there is a receptacle for glass or gelatine films of various tints, which secure many pleasing effects to the eye.

Tracing Apparatus. Designed by S. L. Platt for tracing pictures for crayon and

FIG. 221.

other work. The first step is to procure the enlarged sketches of the picture you propose to make. This do by means of the apparatus described below. This invention can be used by anyone for enlarging any object that can be attached to the top, which is to contain the picture, face down. The enlargement can be made of any size, from 8 by 10 to life-size. The lens, the movable front for focussing, clamps for holding the movable top, which is adjusted from the inside and governs the size of the object; and the reflector, to throw sunlight on the object, will all be seen in the diagram; also, the table or stand upon which the paper or material upon which to draw the image as it is reflected down, is placed. This is a very useful instrument for any gallery. "With it any card can be enlarged to 8 by 10 or larger, and used to show the patron how he would appear in a large portrait, which might induce him to have one made."

Tragacanth. Syn., Gum dragon. A white gummy exudation from the *Astragalus verus* found in Persia and Syria. Soluble readily in hot water and alcohol. Used as a mountant and possessing great adhesiveness for this purpose.

Transfer Paper. Used in some of the photo-mechanical processes, is paper with a gelatinized surface (carbon tissue) which may be sensitized and exposed under a negative or drawing in the usual way. After development the image is "rolled up" with suitable ink and transferred to the base of zinc or stone for after-treatment, according to the process employed.

Transfers. Pictures secured by transferring a positive image after treatment upon a temporary support to its final support, the picture being generally, but not always, reversed during the process. Transfers may be most easily obtained by the collodion, carbon, and "transferrotype" method.

Transferring "Aristo" Prints. Almost any of the collodion papers can be printed, toned, and fixed as usual, and then when dropped into boiling water the film will peel off the paper within a couple of minutes. For some purposes it can at once be placed on its support, and the operation is completed; but in the case of watch-crystals, or where the support is to give the background tint, it is necessary to rub off the paper coating which adheres to the collodion. This can be done by first laying the print face down on a glass and then rubbing it gently with a tuft of cotton wetted with hot water; this treatment brings the print as clear as a wet-plate transparency, and it can now be transferred to any surface. It is found best, however, to coat the support

with a comparatively strong substratum of gelatine, and allow it to dry; then when the transfer is to be made the prepared support is slipped into clean water under the cleaned print; this allows the substratum to soak up as much water as it will, and if air-bubbles are pressed out from under the print there is perfect contact between the film and its support. With careful manipulation gelatino-chloride prints may be similarly transferred, the gentle application of steam to the back of the print upon the temporary support taking the place of immersion in hot water.

Transferring Collodion. The process for detaching the collodion positive from the glass plate and fixing it upon some other substance. Many methods are given to effect this:

1. To 1 ounce of alcohol add 10 drops of nitric acid. Pour this mixture on and off the picture till the film begins to loosen; also wash the surface to which the picture is to be transferred, until it is slightly softened. Now lay the latter carefully on the glass, pressing out air-bubbles, and place the whole under pressure, of a few pounds' weight, for an hour or two. At the end of this time the leather, paper, or other substance may be taken from the glass, and the picture will be found to adhere perfectly.

2. Take of India-rubber 1 ounce and dissolve it in 2 ounces of camphene. Take 3 ounces of asphaltum and dissolve, by gentle heat, in 6 ounces of turpentine and 8 ounces of boiled oil; when it is all dissolved add the dissolved rubber. After letting it stand for a few days to settle, decant into a flat dish and float your paper upon it, hanging up by a corner to dry. Repeat the process until you have a smooth surface. If the solution is too thick add turpentine and boiled oil in the ratio of 6 of the one to 8 of the other. Keep the paper free from dust and it will keep any length of time. After taking your picture and drying it, pour on alcohol slightly acidified with nitric acid, then coat your paper in the same way; drain off into a bottle for future use. Then, with the plate in one hand and the paper in the other, dip in clear, soft water several times, after which lay the plate on the table, collodion side up, and put your paper upon it, rubbing it gently to free it from air-bubbles and superfluous fluid; when smooth it is ready to be taken from the plate. Dry and mount. Thick collodion is better for transferring than thin.

3. Dissolve shellac in boiling water with a little borax; grind some lamp-black with it; coat the positive smoothly (using a camel's-hair brush) and allow it to dry. Then coat a piece of paper of the required size with the same mixture, and while wet place it on the positive, rubbing it firmly to prevent bubbles. Let it dry thoroughly, then immerse it in water for a few minutes, and the whole of the film will leave the glass. The formula for the above mixture is: Shellac, 4 drachms; borax, 1 drachm; boiling water, 4 ounces.

4. Half fill a bottle with benzole, and fill it up with shreds of gutta-percha; then place the bottle in hot water until the whole of the gutta-percha is dissolved, and put it by to settle. When settled pour off the clear part into another bottle. When required for use, the bottle should be placed in warm water. The positive having been varnished some time previously, should be placed on a levelling stand, and sufficient of the gutta-percha poured on to cover it well up to the edges; this should be allowed to remain on a few minutes to set partially, and the glass should then be tilted very gradually to allow the surplus solution to flow back into the bottle; then hold the back of the glass to the fire until the gutta-percha has set. It will be better not to proceed with the transfer until the next day. Having cut some black paper rather larger than the positive, place it on a board and cover it well by means of a broad flat brush, with thick gum-water into which has been put a small quantity of spirits of wine to prevent its turning acid; then put the glass with the positive into cold water, and allow it to remain until you find by lifting one corner of the collodion film that it will separate easily from the glass. Now carefully remove the moisture with blotting-paper. The gum side of the black paper must then be gradually lowered on to the positive, commencing at the lower end, and smoothing the paper as it falls with the finger. When dry, by lifting one end of the paper it will bring away the collodion film with it, and, if carefully done, perfectly smooth and free from air-bubbles.

5. First take a negative picture in the ordinary way; back this picture with plaster of Paris, mixed into a paste, just such as

will flow easily, and pour on to the collodion surface. Over the plaster apply a piece of muslin, or other open fabric, and then pour on more plaster, and so on until the required thickness is obtained. When you wish to remove the glass from the picture, coat the glass with a thin solution of gum before applying the collodion, which allow to dry; after taking the negative and putting on the plaster, soak the picture in warm water, which dissolves the gum and leaves the picture on the plaster. When dry the picture has a shining appearance, and to remove this wash the surface with pure ether. To render the picture more suitable for coloring, the plaster is saturated with spermaceti or wax. To strengthen the plaster it is cemented by shellac to mill-board or other suitable substance.

6. Make a solution of gelatine, 4 parts; water, 100 parts; pour it while warm into a warm dish; float your paper upon this for about two minutes, or until the paper has become quite flat upon the solution; then hang it up by one corner to dry. Plunge the picture to be transferred into a dish of water, then take a sheet of the gelatine paper of the size of the glass, and float it on the water which covers the collodion plate; then as soon as the paper has become quite flat, lift up the plate in such a manner that the floating sheet shall be removed, leaving the latter in perfect contact with the collodion film. Now drain away the superfluous liquid as completely as possible, and leave the whole on a level place to dry. For a varnished picture add about 4 per cent. of alcohol to the water. When dry make an incision in its surface all around and close to the edges of the glass; it is then immersed in a shallow dish of water to render the gelatine pliable. After a quarter of an hour you may detach the paper and film from the glass by beginning at one corner and gently raising it gradually. If the film does not separate freely allow it to soak until it does. Finally press the transfer between sheets of blotting-paper and let it dry.

7. Pour over the collodion film a varnish composed of 1 ounce of pure gum mastic dissolved in 8 fluidounces of alcohol, and 2 drachms of poppy oil added; the glass being then placed in a horizontal position, a piece of thin paper cut a little smaller than the glass is saturated, by means of a fine brush, with the same varnish and at once placed carefully in contact with the collodion film, so as to exclude every particle of air, and the whole allowed to become dry by evaporation of the spirit. When dry place the glass in a dish of water, paper side up, until the film begins to separate from the glass, when it is gently and carefully drawn away, and dried as directed for 6. (See also *Gutta-Percha.*)

Transferring Prints. Take any print produced on paper, and treat its surface with three coats of collodion. When this is set and hard, the paper is washed off, when the ink or color will be found firmly attached to the film of collodion. To effect this operation perfectly, the print should be first stretched upon a board and receive the coats of albumen, then put into water to soften it, when it may be easily rubbed off, leaving the design firmly fixed upon a transparent coat of collodion, which is then allowed to dry and afterward is to be varnished with a thin coat of transparent varnish. The collodion may be rendered tough and transparent by adding about 3 per cent. of castor oil and the same amount of Canada balsam to it, and boiling them together in a close vessel until they are thoroughly incorporated. The printed film of collodion is now ready for mounting upon glass. This is done by placing it between two plates, pressing them close together, and cementing their edges by pasting a strip of paper around them. These transfers may be used for magic-lantern slides, or for ornamental windows.

Transfer Roller. A little instrument similar to the blotting roller of the counting-room, covered either with blotting-paper or India-rubber; the latter, however, is best for transfer purposes. To use it pass it backward and forward with suitable pressure over the back of the picture laid upon the transfer block or other substance until the adhesion is complete.

Transferrotype. The name given to an insoluble film of gelatino-bromide emulsion affixed to a temporary support of paper by a substratum of soluble gelatine. These films are obtainable commercially. They are treated precisely as bromide paper is treated, but may be toned when transferred. To transfer such films, squeegee after toning, etc., on a rigid support, allow to dry under pressure, then pour on hot water till the paper backing may be separated from the film.

Transfer Varnish. Take ½ drachm of borax, 3 drachms of fine orange shellac, put them into a jar, and pour ¼ gill of boiling water on them; stir until dissolved; bottle off for use, and color with lamp-black, or any other desirable color, when wanted. Use as directed in "3," in article on *Transferring Collodion.*

Another. Dissolve 1 ounce of gum mastic in 8 fluidounces of alcohol, and add 2 drachms of poppy oil. For use see "7," article on *Transferring Collodion.*

Translucent Paper (Glass-Paper). A fine satin paper, saturated with paraffin, and used for covering the glass of sky- and side-lights, in order to obtain a softer effect.

Translucine. A commercial preparation consisting of an oily lubricant; used for oiling or making film negatives transparent.

Transmit. To send from; to suffer to pass through, as light is transmitted from the sun; or passed through glass.

Transparencies. Positive images on glass, opal, mica, or gelatine films are justly regarded as the most beautiful of all photographic pictures. They are used chiefly for decoration, and for projection in an enlarged size by the optical lantern. Those made for the latter purpose are generally known as lantern slides. For their production any process by which pictures on glass may be secured is available, such as the wet collodion, collodio-bromide, albumen, carbon, transferrotype, gelatino-chloride, and gelatine dry-plate processes. The latter is that most commonly used. A full *résumé* of these various methods may be consulted in Pringle's *Lantern Slides by Photographic Methods*, or Hepworth's *Book of the Lantern*. Emulsions giving excellent transparencies may be gathered from the formulæ under *Emulsions*, and throughout this work. For the production of transparencies by the gelatino-bromide process, good negatives with fairly strong density and contrast, freedom from stain or fog in the shadows, are essential. The plates used should be somewhat slower than those ordinarily used in photographic work; specially prepared "transparency" plates may be obtained commercially. Very much depends upon the tone of the image secured, and this is dependent upon the exposure and developing or toning process employed. Where special plates are used the best results may be obtained by closely following the formulæ sent out by the manufacturer. A few standard formulæ for the development of transparencies and lantern slides are given as reliable in practice:

Carbutt's Formula.

A.	Distilled Water	20 ounces.
	Sulphite of Soda (cryst.)	4 "
	Eikonogen	330 grains.
	Hydroquinone	160 "
	Water to make	32 ounces.
B.	Distilled Water	20 ounces.
	Carbonate of Potash	2 "
	Carbonate of Soda (cryst.)	2 "
	Water to make	32 ounces.

For full exposures take 1 ounce of A, ½ ounce of B, 4 ounces of water, and 2 drops of a 10 per cent. solution of bromide of potassium to each ounce of developer.

Pyro and Ammonia.

A.	Pyrogallol	40 grains.
	Potassic Meta-bisulphite	120 "
	Water	20 ounces.
B.	Liquor Ammoniæ 0.880	2½ drachms.
	Ammonium Bromide	40 grains.
	Water	10 ounces.

For use, mix equal parts of A and B.

Hydroquinone Developer.

Water	1000 parts.
Hydroquinone	15 "
Sodium Sulphite	50 "
Citric Acid	3 "

After development with the above formula, the transparency may be toned in any combined bath used for gelatino-chloride paper.

Eikonogen Developer.

Sulphite of Soda (cryst.)	8 ounces.
Carbonate of Soda (cryst.)	3 "
Eikonogen	1 ounce.
Distilled Water	80 ounces.

Amidol Developer.

Sulphite of Soda (cryst.)	2½ ounces.
Distilled Water	12½ "
Amidol	2 drachms.

One grain of potassium bromide to each ounce of developer may be used, if required, as a restrainer.

Metol Developer.

A.	Water	100 parts.
	Sodium Sulphite	10 "
	Metol	1 part.
B.	Soda	1 part.
	Water	10 parts.

For use take equal parts A and B; using

a few drops potassium bromide as restrainer if required.

Transparencies (Tinting in Monochrome). Wall gives the following method: After development, fixation, and washing of the transparency in the usual way, immerse the plate for one minute in

Sulphite of Soda	1 ounce.
Sulphuric Acid	½ drachm.
Water	3 ounces.

Wash and drain, and apply the following:

Uranium Nitrate	15 grains.
Distilled Water	2 ounces.
Methyl Alcohol	½ ounce.

To which add, from time to time, according to the tint required, a few drops of

Ferricyanide of Potash	15 grains.
Distilled Water	1 ounce.

The action of this is very quick; first brown-black tones appear, then chocolate, reddish-brown, tawny-yellow or orange. The toning can be stopped at any desired point by washing, or obliterated altogether by dipping in a solution of ammonia.

Another formula for the toning of transparencies with uranium nitrate is given under *Uranium*. With transparencies developed with ferrous oxalate, varied tints can be obtained by modifying the uranium bath.

Transparencies by the Wet Collodion Process. Mr. A. P. Higgins has had success with the subjoined formulæ. For cleaning the glass plates use:

Ammonia, 0.88	1 ounce.
French Chalk	3 drachms.
Tripoli Powder	2 "

Pyroxylin for the Collodion.

Sulphuric Acid (commercial)	5 ounces.
Dried Potassium Nitrate (pure)	2 "
Water	1 ounce.
Prepared Cotton-wool	60 grains.

Plain Collodion.

Alcohol	2½ ounces.
Sulphuric Ether	5 "
Pyroxylin, as above	50 grains.

This when dissolved is allowed to stand and deposit any insoluble matter. The clear supernatant liquid is now iodized by the addition of iodides and bromides, as:

Ammonium Iodide	4 grains.
Cadmium Bromide	1¾ grain.
Plain Collodion	1 ounce.

Sensitizing Bath.

Nitrate of Silver	½ ounce.
Distilled Water	6 ounces.
Iodide of Potassium	¼ grains.

Take one and a half ounces of the water, and dissolve the silver in it, and the iodide. Shake well, and then add the remaining water; filter and test for acidity. Should the bath be very acid, add carbonate of soda to produce a precipitate, and then render slightly acid with pure nitric acid.

Developing Bath.

No. 1.	Ammonio-sulphate of Iron	25 grains.
	Glacial Acetic Acid	25 minims
	Water	1 ounce.
	Alcohol	quant. suff.
No. 2.	Pyrogallic Acid	3 grains.
	Citric Acid	1 grain.
	Water	1 ounce.

Fix as usual with cyanide of potassium.

If, after fixing, the plate lacks density, it may be intensified by flooding it with a solution composed of

Pyro	3 grains.
Glacial Acetic Acid	1 drachm.
Water	1 ounce.

To which is added a few drops of a thirty-grain solution of nitrate of silver. Wet-plate transparencies may be toned by flooding them with a weak solution of chloride of gold and chloride of potassium, but most people prefer bichloride of platinum, which must be neutralized, first with carbonate of potassium, and then rendered slightly acid with nitric acid.

Mounting-Paste for Lantern Slides. For attaching lantern-slide bindings to the glass, nothing is better than bichromated paste, which is used for attaching paper to glass in the manufacture of electric instruments, and which is a most useful paste for many purposes in damp climates. It is made as follows:

Flour	2 teaspoonfuls.
Water	4 ounces.
Bichromate of Potash	5 grains.

The flour must be rubbed to a smooth paste with the water, then placed in a saucepan over the fire and kept stirred until it boils. Add the bichromate slowly, stirring all the time; then stand to cool.

This paste must be kept in the dark, and used as soon as possible. Soak the paper in it, and attach to the glass, then place in

direct sunlight for a day. This sets up a chemical change in the bichromate, and renders the paste insoluble. Masks for binding slides can be obtained commercially, or cut from blue-black needle-paper to suit the character of the slides. Transparencies for decoration are usually coated with crystal or matt varnish, and protected by a cover-glass behind the film side, or mounted with a ground-glass plate, the two plates being either bound similar to lantern slides or encased in a light metal frame devised for this purpose and obtainable at the stores. For directions as to coloring lantern slides and transparencies, the reader is referred to Hepworth's *Book of the Lantern*, where full particulars are given. (For details regarding *stereoscopic transparencies*, see *Stereoscopic Pictures*.)

Transparencies. Wet-plate positives for reproduction. These should render an image as transparent as possible, for all half-tone is dependent upon this quality. In the half-tone consists the only value of the picture for reproduction.

Examine the film with a microscope and you will find that the coarser the grain the more gradation of color can be seen through the image, and to secure this employ such a developer as will produce this effect, while causing as white a deposit of silver as possible.

Make the bath of silver nitrate, 65 grammes; water, 1 litre. (A gramme is 15.432 grains; a litre is 1.135 quarts.) Add silver iodide (¼ of a gramme of potassium iodide to 1 litre of water, and re-crystallized silver nitrate, 80 grammes) slightly acid with nitric acid.

Developer. Many use pyro, but the results secured by the beautiful white deposit given by the ferrous nitrate will commend the following formula:

Ferrous Nitrate	7 grammes.
Ferrous Sulphate	3 "
Nitric Acid (1.45)	1.25 c.c.
Alcohol	q. s.
Water	1 litre.

If now the trial plate shows a deposit too granular, modify agreeably by adding more *ferrous sulphate*.

The water for the pyroxylin should be 5° F. below that for negative work, and the acids *weak*, equal parts of sulphuric and nitric acids being used with as much cooled water as they will bear without dissolving the cotton-wool. This collodion should contain more ether than alcohol when such pyroxylin is employed.

Ether (0.725)	400 c.c
Alcohol	300 c.c.
Pyroxylin	10 grammes.

Now add to this plain collodion

Ammonium Iodide	7 grammes.
Cadmium Bromide	1.5 "

It may be well to omit half the alcohol given above and dissolve the iodide and bromide in it, adding some when needed for use. For density put in enough tincture of iodine to give a sherry color. *Don't push development far.*

The plate should by transmitted light look *under-exposed*. If on glass, back it up with black velvet or suitable black varnish.

Fix with potassium cyanide, 30 grammes; water, 500 c.c. Remember that hydrocyanic gas is evolved. *Wash, wash.*

Given a fine positive, what further can be done to improve it? Upon the negative you dealt with all imperfections possible by Lambertype method. Such colors as were rendered lighter than should be, can now be given true value. Coat the back with matt varnish. Deepen all the shadows as you cleared up all the lights on the negative. Strengthen with a pencil all the weak details. Take a print and compare with the faulty first one. Make now a new negative, which varnish and place in an envelope for the reproduction of the desired picture. Any etcher who has taste, skill, and patience to try these methods, will find the results repay him a hundred-fold.

If a work of art is to be reproduced, you must *over-time* a Carbutt B 16 sens. or slower plate, and much *under-develop*, so that the extreme density only stands for half-tones. You cannot succeed otherwise in getting such a print as you should have. Coat the back with matt varnish and with plumbago; intensify all the lights. In skies the greatest failures are observable.

If out of doors, always expose a second orthochromatic plate for the clouds to accompany the view. The clouds should be an aërial echo of the picture. Orthochromatic films are very useful for cloud work, as you can use *each side* as needed. Dilute developer freely; expose very quickly. Reduce your pyro to half-strength, and sal soda at least five-eighths

its strength in summer. If water is in the view, print the clouds first and turn the film over and print in the water not so strongly. The reflections when the landscape is printed over will gladden your eyes.

There should be ripples on the water at the moment of exposure on a landscape; if not, toss in a large stone. It is not artistic to exhibit water so lacking in wetness that one can hardly tell which side up is right for the view. For a fair-weather scene, breathing quiet and peace, choose stratus clouds. For warmth and brightness, cumulus clouds of summer. Do not print too deeply; let them go back in fixing the print. Do not develop them for vigor and contrast. Cover with much tissue and print slowly in diffused light.

When you doctor the negatives remember to be sparing of white. Cirrus or piled-up cumulus should not be white in the picture. It is an excellent plan to fasten the printing-frame to a board suspended by a string, and keep it twisting while printing in the shade. Exert yourself to secure a good sky in each view. Remove one lens of the combination and double your focus, and lessen your angle of view for the sky. Back all cloud plates. —*C. Ashleigh Snow.*

Transparency. In art, that property of the shades in a picture which represents the permeability of light through the natural shadows; a picture on any transparent media. There is no quality in a picture so necessary to its beauty and truthfulness to Nature as transparency, particularly in the shadows, and it is the loss of this transparency which has been the main point of condemnation of the photographic proof in the minds of all true artists. Who has not admired the brilliant velvety tones of a proof seen through the medium of water? "Then it is that we can appreciate the delicacy of the details and the softness of the shadows; but unfortunately the water acts only as a delusive mirage, and the proofs once dry lose a great portion of their brilliancy" by the loss of their transparency. This transparency of the shadows it should be the aim of every photographer to preserve, as upon it depends the truthfulness and beauty of the photograph. The remedy for its loss appears to be in the vigor of the negative and the proper preparation of the paper. On this subject L'Abbé Dupratz thus writes:

"It is well known that when a solution of alkaline chloride is combined with another solution of acetate of silver, there arises a mutual decomposition of the two salts on the one hand, and on the other, a formation of a soluble acetate having as a base that of the chloride employed. The atomic composition of the substance indicates the formulas according to which the mixture is to be made in order to induce perfect decomposition. These proportions, in chemistry rigorously exact, are much less so in photography, as we shall hereafter explain. Notwithstanding the divers degrees of affinity of the chlorine for the bases, it may be admitted that, in a photographic point of view, the alkaline chlorides are all equally efficacious for the decomposition of acetate of silver. Complete indifference as to choice seems to be attended with no detrimental consequence, and if, in practice, some photographers use chloride of ammonia, it is because it is less capable than the others of absorbing the moisture of the air. Special works on photography give all the proportions of alkaline salt and acetate of silver which are to enter the preliminary baths for positive papers. They also indicate the duration of the different immersions. By following these data, we sometimes obtain perfect results, but at others such as often leave much to be desired. Whence arise these varieties in an operation which appears so simple? We have cause to believe that the inferior proofs are given by paper containing chloride of silver, and that the superiority of the others is owing to an excess of acetate of silver. To convince ourselves, let us examine the respective rôles of the two salts in the formation of the photographic picture. The first thing that strikes us is that the action of the light being exercised on compounds of different degrees of impressibility, two distinct effects should result. The action on the chloride of silver is relatively much more prompt and stronger than on the acetate. The first becomes, in a space of time more or less considerable, completely black, while during the same time, the second can only reach a more or less deep fawn color. The union of these two tints seems to us necessary to a complete result, but as this commonly takes place under certain conditions, we will indicate the precautions proper to attain it under all circumstances.

"Let us first show how these two tints

united are to produce the transparent effects in question. To be more intelligible we will draw a comparison. The painter with his devices for obtaining his beautiful transparent effects, seems to hint to the photographer a course analogous to that followed by himself. The painter has his resource in his varnishes; the photographer too has his different degrees of depth in tone, one deep and opaque, given by the chloride of silver deeply blackened by the light; another, much more clear notwithstanding its depth. The first is superficial, the other may penetrate the paper to a greater depth; the latter supports the other, which, in spite of its greater opacity, veils it completely only in the darker shades. In the mean tints, the fawn tint of the acetate of silver preserves its entire power of coloration; it may be observed, moreover, that the ulterior washes exert on it but a comparatively feeble destructive action. If this be the course of things, it may be conceived that the slight contrast of these two superposed tints should strangely contribute to the general harmony of the proof, and assure to it transparency and brilliancy.

"Now what are the conditions under which we are to work, to obtain uniformly the two coatings of silver? As regards this matter, we do not think it possible to proceed with any fixed proportions. The matter before us, as the reader will have apprehended, is not mechanical labor, bur rather the appreciating judgment of the mind which is not to be restrained within any fixed and infrangible boundaries, the nature of which it is always possible to express in a very few words. We will admit in principle, therefore, that to obtain a good positive paper, it should be coated, in the first place, with *a very minute film of alkaline chloride*, and in the second place, with a *proportionately very thick film of acetate of silver*. To produce these two effects, we have several matters serving as guides. First, the duration of the immersion in the two successive baths, the degree of concentration of these two baths, the thickness of the paper, the strength of its sizing, and its degree of permeability; neither should the question of temperature be neglected, and the fact of the baths becoming weak by use should be borne in mind. While the silver bath is gradually growing weaker, it becomes charged, moreover, with a rather noticeable quantity of alkaline acetate, a neutral salt, it is true, but which, by mechanically interposing between the molecules of chloride of silver deposited on the paper, has yet a most disastrous effect, as a paper thus prepared gives only weak ashy proofs. An excess of alkaline chloride in the first bath produces another equally deplorable effect: although the positive paper in such a case gives a very black proof if the immersion be prolonged, yet its too great opacity now prevents the proof from attaining all its desirable delicacy. It may be perceived that in the question before us it is scarcely possible to proceed with any given figures, yet we may have one infallible characteristic by which we may assure ourselves whether the paper has been prepared under suitable conditions; a well-printed proof should be of a *bistre black* in the shades, and of a decided *roseate* hue in mean tints. A general *dark violet* would indicate an excess of chloride of silver and a want of acetate of the same base. Lastly, in order that the operator may enter with greater facility on the course we have laid down, we may observe that under ordinary circumstances we find it well to immerse the paper for two or three minutes in a salt bath, prepared by simply throwing an excess of salt into a vessel of water, and filtering in about five minutes. As to the bath of acetate of silver, it is uniformly prepared at 20 per cent. We submit our salted paper to its action from seven to ten minutes, in order that the solution of silver may penetrate nearly through the paper.

"It may be said that this is shackling a process which heretofore was generally regarded as extremely simple, and as giving uniformly, without much care, results which it was agreed to consider satisfactory. We take no heed of this objection. We take our stand with those true artists who do not deem it right that photography should be degraded to the rank of the purely mechanical, but rather that she should seek to rise to that of the right liberal arts.

"Doubtless, formulæ have their importance, but it is only by a certain appreciation of the judgment that it is ever possible to draw from them their peculiar advantages.

"May we be allowed to draw the attention of chemists here, to the nature of the complex coating we have just been considering? We are aware that this coating has been the object of numerous investigations; the

action of light on chloride of silver in particular has been treated at length. But positive paper is not composed of chloride of silver alone; it always contains more or less free acetate. It is very certain that it acts also on this compound. Acetate of silver in the crystal form is little, if at all, affected by light; but not so when this salt comes in contact with a vegetable matter, such as paper, or animal, as parchment, horn, etc. What is the action of light in these two cases? As to that exercised in chloride of silver, it is said that it exists in the expulsion of chlorine. Can science be content with such a vague comprehension? Does the explanation mean that chlorine is really disengaged and becomes free? If so, there is nothing more easy than to prove it, the reactions of chlorine being well known. A close glass vessel containing a sheet of positive paper, and exposed to the light, should, in a certain period, be filled with chlorine. If light acts in a like manner on acetate of silver, the same experiment made on paper impregnated with this salt should give acetic acid. It is very doubtful to us whether the experiment will produce such results, which results, however, must necessarily take place if there be a real emission of gas or acid. But if there be no evolution of either of these bodies, in what, then, does this mysterious compound of the positive proof consist? Must it be admitted that, through the action of light, the atomic equivalents of the chlorine and acetate of silver have been changed; that the chloride or the acid, for instance, abandoning a portion of the silver, takes to the remainder, or rather forms a peculiar combination with the vegetable or animal substance which they have imbibed? There is nothing to authorize the admission of this hypothesis; but it would be difficult to prove it totally chimerical. In fact, who would dare affirm that under the action of light, new combinations, till now unknown, are completely impossible?

"Let us hope that science will at last penetrate these profound arcanæ of Nature. The chemist will reap glory in their elucidation, and photography will be vastly benefited. It is our belief that positives will never be absolutely fixed until we possess a thorough acquaintance of the elements which constitute them."

Transparent. Permeable by the rays of light. Bodies which allow the light which falls upon their surfaces to pass through them, are said to be transparent.

Transparent Colors. Those colors which permit the light to pass through them, and do not entirely obliterate the substance upon which they are spread, thus giving to these parts of a picture the natural effects produced upon the vision.

Transparent Media. Substances which transmit light.

Transparent Positives. Ambrotypes; positives on glass taken in the camera, or printed under a negative. In previous articles directions are given for the production of these pictures. (*See Ambrotype; Positives on Glass; Printing Transparencies, and Lantern Slides.*) The following instructions of Professor Martin for printing in the camera are added. They contain useful information.

"If the exposure in the camera in printing the positive has been too prolonged, the operator should arrest the development with pyrogallic acid at the instant when there is reason to think that the shadows will not increase in intensity and when there is no deficiency to details. The reduced silver in this case presents a reddish hue. The action of gold does not entirely overcome this color; and, if it be not injurious to positives intended for optical experiments, at least it is not advisable for these to be transferred to paper. The excess of exposure is not the sole cause of the production of this red tint; the presence of an excess of acetic acid in the pyrogallic solution, or in that of the nitrate of silver, the employment of a collodion slightly alkaline, the use of a negative too transparent or too hard, produces it equally. It is not always easy to remedy this defect. As regards the exposure, it is observable that if it be insufficient the proof will be incomplete in the lights, and will only have lights and shades without half-tones. If we reduce the quantity of acetic acid there is reason to fear that the white parts will be insufficiently preserved. Under other circumstances and by the employment of old collodion, rich in iodide and in ether, with baths containing too much free nitric acid, the reduced silver assumes a gray tone, the image, incomplete in the shadows, is veiled, and presents in its whole aspect, even after the action of the chloride of gold, a bluish-gray tone that is cold and disagreeable. The following method has for its ob-

ject the more certain production of this kind of proof."

"The collodion should be a trifle richer in iodide and pyroxylin than ordinary, and the bath about the same.

"The plate, sensitized in the ordinary way, is exposed in the camera for a rather shorter time than when intended to be developed with pyrogallic acid, and the development is effected instead by means of sulphate of iron. Silver thus reduced is white and will only give gray shadows. How can we transform this white into black silver? By pouring on the developed and washed *but not fixed* image a saturated solution of non-acid bichloride of mercury, the reduced silver becomes black by the precipitation of metallic mercury. The proof is then carefully washed, and covered with a solution of cyanide of silver in cyanide of potassium. This solution is obtained by dissolving 48 grains of cyanide of potassium in 1 ounce of water, and adding thereto a sufficiency of a 50-grain solution of nitrate of silver until the precipitated cyanide of silver which results ceases to be re-dissolved on shaking it up. The liquid after filtration is ready for use. We may replace the silver salt by one of copper, which gives the same results. Metallic copper which is thus precipitated is black, and gives to the proof a tone altogether like that produced by the silver. In this case employ the pure crystallized cyanide of potassium. We may in like manner substitute hyposulphite of soda for cyanide of potassium, and prepare the solution in the same way, whether with the silver or copper salt. Hyposulphite of soda, which has served for fixing negatives developed with pyrogallic acid, and of which the action is exhausted, gives, by the addition of silver or copper salt, good results. All the solutions may be used over and over again, especially those of silver, before their efficiency is exhausted. When we flow either of these solutions over the plate, after the action of the mercurial salt, we see the blacks assume great intensity; nothing more is necessary than to wash well and to fix with fresh solution of *hyposulphite of soda*. If the proof is intended to be preserved on the glass, to serve as a transparency, it is only necessary to allow it to dry and to varnish it if it be not already sufficiently transparent. When it is desired to transfer the proof it must be carefully washed after fixing, and be immersed for several minutes in water acidulated with sulphuric acid. The latter operation is necessary, as the collodion will have acquired an excessive adherence to the glass. The same operations are applicable to negatives developed with iron, of which the dark parts appear too gray."

Transparent Spots. Thin spots in the collodion negative through which light is more rapidly transmitted than through other parts, thus producing black imperfections in the positive proof. (See *Imperfections of the Collodion Film.*)

Transparent Varnish. A varnish unmixed with an opaque substance; clear; transmitting light. (See *Varnishes.*)

Transposition. Changing the position of two or more objects from right to left, or from above below; reversal. The transposition of stereoscopic pictures is best effected by cutting the negative through between the pictures and fixing them in the reversed position to a plate of glass by means of sticking paper around the edges. This obviates the necessity of cutting each positive proof before mounting.

Traumaticin. A solution of gutta-percha in chloroform.

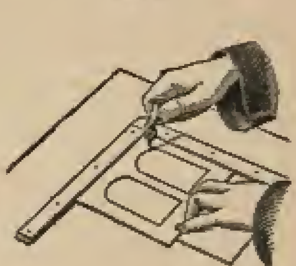
Treble Glass Pictures. (See *Stereoscopic Ambrotypes.*)

Trihydroxy-Benzene. (See *Pyrogallol.*)

Trimethylamine. $(CH_3)_3N$. An extremely volatile liquid, boiling at 10° C.; having a herring-brine smell, from which it is distilled. Employed mix with pyrogallol in alkaline development.

Trimmer. An instrument for trimming paper pictures, consisting of a handle and a

FIG. 222.



sharp steel wheel, turnable in all directions. The cutting is done with the aid of glass or

metallic forms. The invention of Professor Robinson.

The engraving illustrates the method of using Robinson's revolving trimmer for trimming prints of irregular shapes. A metal guide is used—oval, arched-top, or other form.

Trimming Prints. Prints of all kinds may be trimmed (or cut to any desired shape) when dry by the use of a glass cutting shape of the size required. The print being laid upon a smooth, hard surface (zinc is preferable), the cutting shape is laid upon it and a sharp knife-blade or "trimmer" is run along the edges of the shape.

To Trim Prints When Wet. Place a piece of manilla paper on a *smooth board*. Lay the wet print on this paper. Place the glass guide in position and trim with a sharp knife, just as if the print were dry. If the knife is *sharp* there is no possible danger of tearing the edges of the print.

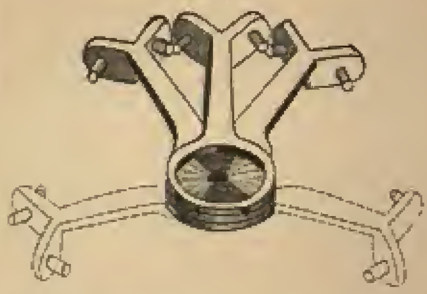
Triple Dark-Slide. A holder admitting of three exposures upon one and the same plate.

Triple Lens. Triple achromatic; an objective consisting of three lens systems. Dallmeyer's triplet contains two pairs of condensing lenses, with a pair of diffusing lenses between. It is free from aberration and distortion, but much slower than the aplanat, which supersedes it. Zeiss' triplet (aprochromat) consists of two single crown-glass menisci, with triple cemented correction-lens of borate flint glass of less diameter. This central system effects the entire spherical and chromatic correction of the objective. It is free from spherical aberration, distortion, and ghost, and is corrected for three different colors of the spectrum. View field or angle, 90°. It is a universally useful objective.

Tripod. A three-legged stand for the camera for outdoor work. The legs are attached to a wooden or metal head when in use, and may be separated and folded together when not in use. There are various forms and sizes.

Tripod Head. That part of the tripod which holds the three legs together and upon which the camera is fastened. Has either a triangular or circular form, and is made of wood or metal. Mr. D. A. Partridge, the inventor of an ingenious tripod head, describes it as follows: "It is of brass, having three arms, connected at the centre by a compass joint, so arranged that when not in use it can be folded like a partially closed fan, and supplied with stops that hold the arms when open in the proper

FIG. 223.



position for adjusting the legs. The objection to a rigid tripod head is that it occupies considerable space and is often a clumsy article to carry."

Mr. F. S. Smedley describes his spherical tripod head (see Fig. 224) as follows:

"The cuts and dimensions which I give are for a top which I have found rigid with a box 6½'' x 8½'' or smaller. The figures and a brief description will enable anyone to construct one for himself, I think. The principle is so old and so good that I do not understand why such tops are not on the photographic market.

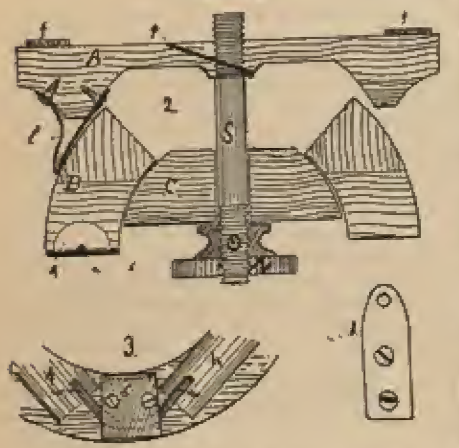
"Any set of tripod legs can be used with this top by fastening to their top ends six ears of brass (1½'' x ½'' x 1/16'') of the shape shown in 1 (Fig. 224), these ears to project ½'' above top of leg. Any boy handy with the lathe can turn up the woodwork either in a chuck or on a screw-centre. Hard wood, little given to warping, is what you will want. The brass-work is simple.

"2 (Fig. 224), is a vertical section through the centre of the top. The top piece, *A*, is a disk (4½'' x ¾'') turned out on the bottom as shown. A ring of felt, *f*, is glued to its top. The camera-screw, *S*, is forced through its centre and secured by a pin, *p*, drilled through it. Three pieces of brass (1/16'' x ⅜'' x 2'') bent to form shown at *l*, placed 120° apart around *A*, form the points by which the top, *A*, rests on the spherical section, *B*.

"*B* is turned from two disks (4'' x ¾''), glued firmly with their grain at right angles to avoid warping. Make accurate semicir-

cles of cardboard with radii of 2″ and $1\frac{3}{4}$″, to be used as guides in turning the outer and inner spherical surfaces of *B*, and also the upper surface of *C*. (A sharp penknife, a bradawl, a hard cabinet mount, and a short bar of wood will give you these curves.) The spherical surfaces all centre at *O*, in the lower (plane) surface of *B*. The block, *C*, is turned from a disk $\frac{3}{4}$″ x $2\frac{1}{2}$″, and is bored centrally. The lugs for the legs are on the

FIG. 224.



under (plane) surface of *B*, which is *gouged out* (see *h* in 2 and 3) to leave room for the ears (1).

"3 shows lower (plane) surface of *B*, and the way of making and attaching one pair of these lugs.

"A steel wire ($\frac{1}{8}$″ x $1\frac{1}{2}$″), *w* in 2 and 3, is bent as shown and firmly soldered to a piece of brass, *b* ($1\frac{3}{4}$″ x $\frac{5}{8}$″ x $\frac{1}{16}$″). This is fitted to under surface of *B*, and fastened with screws. Finish the woodwork against moisture with a heavy coat of shellac.

"From the figure it will now be seen that by loosening the nut, *N*, the top, *A*, with camera attached, can be moved about 20° in any direction or turned to any point on the horizon, while tightening *N* will make the whole top rigid at any point.

"This has saved me not a little in time and temper. I believe it will do the same for you if you will try it."

Tripod Stand Securer. An arrangement consisting of three cross-pieces fastened together in the middle and attached between the three weights to prevent them slipping when on marble or smooth ground. Rubber boots, placed over the metal points of the legs, are sometimes used instead. Many other additions to tripods have been offered. The dealers offer a choice.

Tripoli. An earthy substance, originally brought from Tripoli, hence its name. It has a dull argillaceous appearance, but is not compact, like rottenstone. It has a fine hard grain, but does not soften by water or mix with it. It is principally silica, and has been found to consist almost wholly of the shells of microscopic animalculae. It is used in photography for cleaning glass and the daguerrotype plate.

Trithionate. A compound of trithionic acid with a base. Trithionate of soda, one of these salts, is formed in the toning-bath by the addition of an acid or by age.

Trithionic Acid. One of the polythionic series of acids composed of three atoms of sulphur and five of oxygen.

Tungstate of Sodium. Na_2WO_4. Colorless prisms, very soluble in water, insoluble in alcohol. Used in the preparation of permanent gold baths.

Turmeric. The root of the *Curcuma longa* and *rotunda*, a plant that grows in the East Indies. Its coloring principle is called *curcumin*. Turmeric is employed as a dye and as a test for alkalinity. The yellow color given to test-paper by turmeric is changed to a brown when treated with an alkali; it is, however, less sensitive than reddened litmus paper, and is scarcely affected by the weaker bases, as oxide of silver, and is therefore less used.

Turpentine. Genuine Venice turpentine is the product of the *Larix Europæa*, but this is now scarcely ever met with in trade. That of the shops is wholly a fictitious article, made as follows: Black rosin, 48 pounds; melt, remove from the heat, and add oil of turpentine 2 gallons. Oil of turpentine is obtained by distilling, with water, the semi-fluid sap or pitch called in commerce *crude* turpentine, which exudes from incisions made in the wood of various species of pine. The product left after distillation is a resinous solid, popularly termed *rosin*. Oil of turpentine is a thin, colorless liquid, highly inflammable and possessing a powerful odor. It has a specific gravity of 86, and boils at 312° F. It is nearly insoluble in water, but

dissolves freely in alcohol and ether. Oil of turpentine is extensively used as a solvent for resins in the manufacture of varnishes; in the preparation of paints, and in medicine. India-rubber, gutta-percha, and wax readily dissolve in it.

Turpentine Oil. $C_{10}H_{16}$. Colorless, thin liquid, strongly smelling of rosin, insoluble in water. Used in the manufacture of varnishes and for cleaning printing-blocks or clichés in mechanical processes.

Turpentine Wax-Paper Process. A process analogous to the "*Camphene Wax-Paper Process.*" Camphene being the purer article of the two substances is undoubtedly the best solvent for the wax. (See *Camphene Wax-Paper Process.*)

Typographic Glass Method. A glass plate of considerable thickness is coated with a film of sensitive bitumen, and when dry, a fatty impression is put upon it as in the transfer process. The image is then dusted over with metallic powder and exposed until the bitumen is made insoluble. Development is effected with turpentine or benzole as usual. The plate is afterward etched with hydrofluoric acid to the required depth, and may be printed from in a collotype press.

Typogravure. A sensible name suggested to designate half-tone relief photo-engraved blocks, which may be printed from simultaneously with type matter.

U.

Ulmin. This name has been given to a peculiar substance examined by Klaproth, in 1802, and which was a spontaneous exudation from the trunk of a species of elm (*Ulmus nigra*). It has since been observed on many other trees. When dry, it is hard, blackish, resinous, readily soluble in the mouth, but insoluble in alcohol and ether. It may be formed artificially by heating caustic potassa with wood, by the action of sulphuric acid on vegetable matter, and by combining gallic acid with ammonia and exposing the compound to oxygen.

Umbrella Stand. A tripod, which, when folded, resembles an umbrella.

Uncorrected Lens. Lenses that have not been corrected for spherical or colorific aberration. (See *Lenses.*)

Under-Exposure. A fault brought about by interrupting the action of light upon the sensitive plate in the camera, when exposing too soon for perfect results. In developing undeveloped plates, the high-lights alone appear in a reasonable length of time, while the shadows hang back till the high-lights have become too dense. Such negatives are harsh and chalky. (See *Reducers*, etc.)

Uneven Surfaces. Convex, concave, or undulating surfaces. On such surfaces it is difficult to obtain photographic impressions.

Universal Cement. This may be used for many purposes in photography, and is thus made: Take curdled skimmed milk, press out the whey, break the curd in small pieces, dry it, and grind it in a coffee-mill or mortar. Take 10 ounces of this dry curd, 1 ounce of fresh burnt quicklime, and 2 scruples of camphor. Mix the whole intimately, and preserve in small wide-mouth bottles, closely corked. When it is to be used, mix it with a little water, and apply it immediately.

Universal Developer. A developer which is said to give clear, crisp negatives with many different brands of gelatine dry plates of all rapidities is as follows:

A. Hydroquinone	160 grains.
Bromide of Potassium	30 "
Sulphite of Soda	2 oz. (avoir.)
Water to make	20 ounces.
B. Soda Hydrate	100 grains.
Water	20 ounces.

For use, take equal parts A and B.

Universal Lens-Flange. A separate lens-flange having an inner construction of movable metal sheaths, by means of which the opening of the flange may be enlarged or reduced to securely hold lens-tubes of varying diameter.

Unsized Paper. Paper unprepared with size and more or less porous. It is recommended by some for photographic purposes, but it is not so good as that which is sized.

Uran-Glass. Glass colored yellow with oxide of uranium; possesses fluorescence.

Uranic Oxides. The principal uranic oxides are: I. *Peroxide of Uranium*, which is precipitated as a yellow hydrate when a pure alcohol is added to a solution of pernitrate of uranium and as a carbonate when carbonates are used. It is soluble in alkalies in excess, acting the part of a feeble acid. II. *Protoxide of Uranium*, which is characterized by its green color. With

prussiate of potash the salts of protoxide of uranium yield a reddish-brown precipitate resembling prussiate of copper, and with infusion of galls a brown one. The uranic oxides are now used in photography for printing purposes.

Uranium. A metal discovered in 1789, and named after the planet uranus, which was discovered about the same time. A somewhat rare metal obtained from an ore called pitchblende. By treating this ore with nitric acid, uranium nitrate $UO_2(NO_3)_2+6H_2O$ is obtained in the form of light yellow crystals.—*Harrison.*

The salts of uranium are chiefly used in the processes of photography for printing, intensification, and the toning of transparencies. The theory of their manipulation is analogous to that given for the ferric salts; in presence of organic matter uranium nitrate is reduced by the action of light to the uranous state, and is developable similarly to the salts of iron.

Printing. If suitable photographic paper is floated for five minutes on a bath composed of

Uranium Nitrate	80 grains.
Distilled Water	1 ounce.

and when dry, exposed to sunlight under a negative, an image visible only in its chief details is obtained. If the exposed picture is immersed in a solution of nitrate of silver a black image results from the precipitation of metallic silver upon the uranous oxide. In this case the silver acts as a developing agent, and the image must be fixed in a weak solution of hypo soda. If, however, the nitrate of silver is mixed with the uranium in the sensitizing bath, we obtain a direct print-out paper, which only needs to be fixed in weak hypo-soda solution and washed to be permanent. Abney recommends development with potassium cyanide, after which thorough washing in acidulated water fixes the print. Gold or platinum may also be used as toning agents, and a variety of tones be thus obtained.

To obtain black tones on albumen paper the following formula is advised:

Borax	1½ drachms.
Uranium Nitrate	4 grains.
Chloride of Gold	3 "
Water	24 ounces.

The gold and uranium must be neutralized before mixing, and the bath should be made up 24 hours before use. This bath works best at a temperature of 60 or 70° Fahr.

Intensification. The use of uranium nitrate as an intensifier was first suggested by Selle, of Potsdam. Herr E. Vogel suggests the subjoined formula:

(1)	Nitrate of Uranium	15 grains.
	Distilled Water	4 ounces.
(2)	Ferricyanide of Potassium	15 grains.
	Distilled Water	4 ounces.

For use, take

50 Parts No. 1.
10 or 12 parts Glacial Acetic Acid.
50 Parts No. 2.

This solution, kept in a dark-brown bottle, may be used again and again. The negative, well washed or dry, is immersed in the solution, and the dish is continuously rocked during the operation. After intensification the negative should again be thoroughly washed.

To reduce an intensified negative, locally or otherwise, apply with a brush weak ammoniacal solution (1 part ammonia at 96° in 20 parts water). The intensification fades wherever the ammoniacal solution is applied, and various effects may thus be secured.

Toning Lantern Slides with uranium nitrate is effected as follows. Make up the subjoined solutions:

(1)	Uranium Nitrate	1 part.
	Water	100 parts.

If the solution is turbid, filter until clear.

(2)	Ferricyanide of Potassium	1 part.
	Water	100 parts.
(3)	Ferrichloride	1 part.
	Water	10 parts.

The slide to be toned should be developed as usual, or until it looks somewhat flatter than is desired when finished; fix and thoroughly wash as usual. To obtain *blue* tones immerse it in equal parts 1 and 2 until very dense. Rinse and again immerse in 1 part No. 3 and 5 parts water, for five minutes. Wash and dry. Other tones are attainable by modifications similarly effected.

Uranium Printing Process. A photographic process in which the salts of uranium take the place, partially or wholly, of nitrate of silver. Several formulæ are recommended for this process.

I. *Niépce de St. Victor's Process.* Prepare the paper with a solution of the nitrate of uranium; strength, 10 per cent. Leave the paper for 15 or 20 seconds upon the solu-

tion, and dry in the dark. If dried before the fire it becomes more sensitive to light. The paper may be prepared several days in advance. The exposure in the pressure-frame varies according to the intensity of the negative and strength of the light, from 3 to 10 minutes in sunshine, and from 1 to 2 hours in the shade. On removal from the pressure-frame, wash the print for a few seconds in hot water; then immerse it in a solution of prussiate of potash of the strength of 2 per cent.; in a few minutes the print develops of a beautiful red color. Wash in several waters, until the water is clear, then hang up to dry. To tone this red print, put it into a solution of perchloride of iron, strength about 5 per cent., and to which 1 per cent. of pure hydrochloric acid is added. In a few minutes the print becomes green-black. Then remove it and wash it in pure water, in which it takes a beautiful black tone, which it keeps when dry. The black is more or less intense according to the size of the paper. You must not leave it too long in water, particularly if it is a little alkaline, because the print takes a reddish tone; the reason of which is that ammoniacal water turns the print red, while acid water turns it blue. The red proof may be colored green by means of nitrate of cobalt, and under the influence of heat you obtain a very intense green. Unfortunately, this color loses much of its brilliancy by hydrotation, and particularly by light. Sulphate of iron, as a fixing agent, ends by turning it blue, which is not the case if you employ perchloride of iron without adding hydrochloric acid. The iron solution should be weak, and the print should be left a short time in it, and well washed in pure water, and dried before the fire. It remains then of a beautiful green color.

II. *Mr. William Clark's Process.* This new process of photography consists in taking a sheet of paper which has been kept in the dark for a number of days. This paper must be immersed in a solution of azotate of uranium, until the tint is of a nice straw color, and after it is dried, kept in obscurity. When it is desired to operate with this sheet of paper, it is covered by a negative, exposed to the sunlight for fifteen minutes, then withdrawn and treated with a 6 per cent. solution of azotate of silver, when a print of a chestnut color is developed. To fix this print it suffices to wash it in pure water. If after having washed the print it is desired to transform it into a black tint, it must be treated in a solution of chloride of gold of about $\frac{1}{10}$ per cent. and again washed in pure water. It may be also rendered black by putting it into a solution of bichloride of mercury for a few minutes; then wash in pure water and place on solution of azotate of silver until the desired degree of blackness is obtained; wash again in pure water. Chloride of gold may be substituted for the azotate of silver, in which case the print will be of a blue-black color. Or, after the sheet impregnated with the salt of uranium has been exposed to the light, the image may be instantaneously obtained by treating it with a solution of chloride of gold; in this case the print has a very dark-blue tint; it is finally washed in pure water. The solution of azotate of uranium may be replaced by a solution of tartaric acid, or of citric acid, or of oxalic acid, or of sulphate of alumina, or of citrate of iron, or of arsenious acid, or of neutral tartrate of potash, and of lactic acid; all of which substances having much the same properties as the salts of uranium, but they will not produce the indelible impression as by the salts of uranium. Positive proofs on glass may also be obtained by replacing the albumen with gum containing azotate of uranium, and developing with either chloride of gold or azotate of silver, submitting the paper to light sufficiently long to allow of instantaneous development.

III. Albumenize a sheet of paper, omitting the salt, and hang it up to dry. Float the back of it upon hot water to coagulate the albumen, and again dry. Float it upon a strong solution of nitrate of uranium, and dry it in the dark. Expose it in the pressure-frame under a negative for about the same length of time as for an ordinary print, and develop by immersing in a 20-grain solution of nitrate of silver, which may be used a great number of times; then wash it well in cold water, and lastly in boiling water, and immerse it in a very weak bath of bromide of potassium; then wash again to remove the bromide, dry and the print is finished.

IV. *M. de Brébisson's Process.* Prepare the paper with a solution of 186 grains of nitrate of uranium to 3½ ounces of water. Immerse the sheet for five minutes, and pin it up by one corner to dry. Expose under a clear negative to very strong light, somewhat longer than for a silver print. Develop with a solution of 62 grains of nitrate of silver to

3½ ounces of water. This bath will serve until it is quite exhausted. Tone with chloride of gold solution of 1 per cent. added to water in the proportion of 5 drachms of the solution to 7 ounces of water. Finally wash in several waters, fix in a bath of fresh hyposulphite of soda, strength 8 per cent. (40 grains to the ounce), and wash again thoroughly.

V. *Mr. Hamdry's Process.* First prepare the paper with gelatine and nitrate of uranium; dry; expose in the sun from 1 to 15 minutes. The picture, faintly visible, is then intensified with aceto-nitrate of silver of the usual strength for paper negatives; in 30 or 40 seconds all the details should appear. The print is then placed upon the surface of the following bath:

Water	100 parts.
Protosulphate of Iron	6 "
Acetic Acid	4 "

Tone in a bath of chloride of gold, strength ½ grain to the ounce of water, after washing; wash again thoroughly, and dry. The iron-bath is very energetic, and the print must be washed when placed in it. (See *Nitrate of Uranium Process.*)—*H. H. Snelling.*

Uranous Nitrate, or Azotate. This is formed by exposing nitrate of uranium to the action of light. Reduces silver, gold, and platinum solutions.

Urate of Ammonia. Urate of ammonia is a natural secretion, found in large quantities in the urine of birds of prey, in human urine, and very nearly in a pure state in the solid urine of the boa-constrictor.

Urea. A crystalline, colorless, transparent substance found in urine.

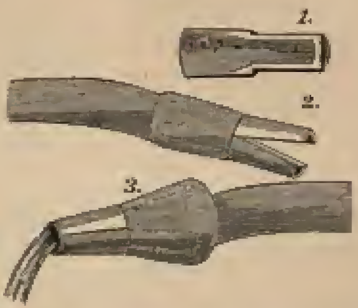
Uric Acid. An acid contained in the urine of man and of certain animals, also in the excrement of serpents and several birds of prey.

V.

Valency. The combining power of elements is called *valency*, but the more common term is "atomicity."

Valve Tap. The following diagram will explain it. 1 and 2, Fig. 225, represent pieces of wood hollowed out inside and rounded outside, made to fit together. 3 shows them fitted together in an India-rubber tube reaching from a water-tank. By pressing the wood, outside the tube, between the finger and thumb, the valve opens, and a thin

FIG. 225.



stream of water, suitable for washing a plate, flows steadily, and ceases when the pressure is removed.

Vanadium. This metal forms four compounds with oxygen, and thus furnishes four series of salts, which are of little importance in photography. Messrs. Lumière Bros., after an exhaustive series of experiments, have produced an energetic developer by reducing vanadic acid by zinc in sulphuric acid. An alcoholic solution of vanadic chloride spread over gelatinized paper gives a surface feebly sensitive to light, which may be intensified and fixed. The yellow solution of potassic-vanadic tartrate admits of the preparation of a very sensitive photographic paper, but the image obtained is feeble.

Varnish. To render negatives and positives on glass, paper, or other supports impervious to the action of the air, damp, or changes of temperature, it is advisable to coat them with a varnish composed generally of a resinous substance dissolved in a volatile liquid, or collodion, or India-rubber in solution. The subjoined formulary includes sufficient for almost all photographic purposes:

Varnishes to be Applied to Heated Negatives.

Orange Shellac	2 ounces.
Sandarac	2 "
Canada Balsam	60 grains.
Oil of Lavender	1 ounce.
Methylated Alcohol . . .	16 ounces.
Bleached Lac	4 "
Alcohol	20 "
Camphor	¼ ounce.

Varnishes which are Applied to Cold Negatives.

Amber	1 ounce.
Chloroform or Benzole	16 ounces.

Amyl Acetate	10 ounces.
Pyroxylin	144 grains.

Sandarac	40 ounces.
Dammar	40 "
Benzole	1 ounce.

Matt Varnishes for Positives on Glass.

Make a solution of white wax in ether and apply to the positive.

Sandarac	1 ounce.
Alcohol	6 ounces.

Dissolve and add 1½ drachms of castor oil.

Benzole	90 parts.
Alcohol	10 "
Gum Dammar	8 "

First dissolve the gum dammar in alcohol and then add the benzole. This varnish is of course inflammable.

Varnishes for Ambrotypes or Backing Positives.

Asphaltum	½ ounce.
Canada Balsam	1 "
Turpentine	1 "

Asphaltum	½ ounce.
Masticated Rubber	15 grains.
Benzole	1 ounce.

Retouching Varnishes.

Dissolve gum dammar in turpentine until a consistence of thin cream is secured. To thin this solution, add turpentine; to thicken, leave the bottle uncorked for a day or two.

Sandarac	1 ounce.
Castor oil	80 grains.
Alcohol	6 ounces.

First dissolve the sandarac in the alcohol, and then add the oil.

Varnish to Render Films Transparent.

White Paraffin Wax	6 ounces.
Petroleum Spirit	2 "

Anti-Halation Varnishes.

Aurine	2 grains.
Plain Collodion	1 ounce.

Powdered Burnt Sienna	1 ounce.
Gum Arabic	1 ounce.
Glycerine	2 drachms.
Water	10 ounces.

Shake well before using.

Colorless and Transparent Varnish.

Copal (soft)	1 part.
Benzine	10 parts.

To be used cold. (See further details following.)

Varnish. A solution of resinous matter which, when spread thin upon the surface of a solid body, becomes dry, and forms a glossy, transparent coating, impervious to air and moisture. Varnishes may be divided into two kinds, viz., *spirit* and *oil varnishes.* Concentrated alcohol is used as the solvent in the former; and fixed or volatile oils, or mixtures of the two, for the latter. The sp. gr. of alcohol for the purpose of making varnishes should not be greater than 0.820. Camphor is often dissolved in it to increase its solvent powers. The oil of turpentine, which is the essential oil chiefly employed, should be pure and colorless.

Pale drying linseed oil is the fixed oil generally used for varnishes, but poppy and nut-oil, benzole, and naphtha are occasionally employed. Among the substances dissolved in these menstrua are copal, mastic, lac, elemi, sandarac, anime, benzoin, dammar, and amber to impart body, and lastic, gamboge, turmeric, saffron, annotto and Socotrine aloes to give a yellow color; dragon's blood to give a red tinge; asphaltum to give a black color and body; caoutchouc to impart body, toughness and elasticity. In the preparation of *spirit varnishes* care should be taken to prevent the evaporation of the alcohol as much as possible, and also to preserve the portion that evaporates. On the large scale a common still, mounted with its head connected with a proper refrigerator, should be employed. The capital should be furnished with a stuffing-box, to permit of the passage of a vertical stirring rod, connected with a stirer at one end and a working handle at the other. The gum and spirits being introduced, and the head of the still closely fitted on and luted, heat (preferably that of steam or water-bath) should be applied and the spirit brought to a boil, when the heat should be partially withdrawn and agitation continued until the gum is dissolved. The spirit which has distilled over should be then added to the varnish, and, after thorough mixture, the whole should be run off through a silk-gauze sieve into stone jars, which should immediately be corked down, and set aside to clarify. On a small scale,

spirit varnishes are best made by maceration in close bottles. In order to prevent the agglutination of the resin, it is often advantageously mixed with clear silicious sand or powdered glass, by which the surface is much increased and the solvent power of the menstruum promoted.

In the manufacture of *oil varnishes*, one of the most important points is good drying oil. Linseed oil for this purpose should be pale, limpid, brilliant, scarcely odorous, and mellow and sweet to the taste. On a large scale, 100 gallons of such oil are put into an iron or copper boiler, of the capacity of 150 gallons, and gradually heated to a gentle simmer for two hours to expel moisture; the scum is then carefully removed and 14 pounds of real litharge, 12 pounds of red-lead, and 8 pounds of powdered amber (all carefully dried and free from moisture), are gradually sprinkled in; the whole is then kept well stirred, to prevent the driers sinking to the bottom, and the boiling is continued at a gentle heat for three hours longer; the fire is next withdrawn and in twenty-four to thirty-six hours the scum is carefully removed and the clear supernatant oil is decanted. This forms the best boiled or drying oil. In the preparation of oil varnishes the gum is melted as rapidly as possible, without discoloring or burning it; and when completely fused, the oil, also heated to *nearly* the boiling-point, is poured in, after which the mixture is boiled till it appears perfectly homogeneous and clear like oil, when the heat is raised and the driers (if any be used) gradually and cautiously scattered in and the boiling continued, constantly stirring for three or four hours, or till a little when cooled on a palette-knife feels strong and stringy between the fingers. The whole is next allowed to cool considerably; but while still *quite fluid*, the turpentine, previously made *moderately* hot, is cautiously added and the whole thoroughly incorporated. The varnish is then run through a filter or sieve into stone jars and set aside to clarify by subsidence. When no driers are used, the mixture of oil and gum is boiled till it runs perfectly clear, when it is removed from the fire, and, after it has cooled a little, the turpentine is added as above. It is generally conceived that the more perfectly the gum is fused, or "run," as it is called, the greater and stronger will be the product; and the longer the boiling of the gum and oil substance is continued, within moderation, the freer the varnish will work and cover when made. An excess of heat renders the varnish "stringy" and injures its flowing qualities. For pale varnishes, as little heat as possible should be employed throughout the whole process. The use of too much driers injures the brilliancy and transparency of the varnish. From the inflammable nature of the materials of which varnishes are composed, their manufacture should be only carried on in a detached building, built of uninflammable material. When a pot of varnish takes fire it is most easily extinguished by covering it with a piece of stout woollen carpeting, which should be always kept ready for the purpose.

The qualities in varnishes necessary for *photographic* purposes are extreme hardness, perfect transparency; when for negatives or paper positives, smoothness, limpidity, penetration, and non-contractibility; and no liability of cracking from any cause whatever. In regard to the gums used it is well known that some contain in themselves a natural tendency to crack, and these consequently should never be used for negatives or positives without the addition of some other gum or gums which may counteract this tendency. All gums that swell up in water *like glue* are liable to produce a cracking varnish. Of the varnishes which follow those marked P are the best for photographic purposes. (See *Varnishing*.)—*H. H. Snelling.*

Varnish, Albumen. (P.) To 100 parts of albumen add 10 parts of clear honey and 1¼ parts iodide of potassium, using a little yeast to ferment the mixture. After fermentation the liquid must be filtered and stored in 4 or 6-ounce bottles, well corked, and avoid long exposure to air of bottles in use. This is a good varnish for negatives, and can be spread on the cold plate, but after spreading and drying it must be dipped into the ordinary aceto-nitrate bath, washed immediately and then immersed in hyposulphite of soda. A final washing concludes the operation.

Varnish, Amber. 1. Amber, pale and transparent, 1½ pounds; fuse; add hot clarified linseed oil, 2 quarts; boil till it strings strongly, cool a little, and add oil of turpentine, 1 gallon. This varnish is pale as copal; soon becomes very hard and is the most durable of oil varnishes.

2. Amber, 1 pound; melt, add Scio tur-

pentine, pound; transparent white resin, 2 ounces; hot linseed oil, 1 pint; and afterward oil of turpentine, quantity sufficient as above.

3. Melted amber, 4 ounces; hot boiled oil, 1 quart; as before.

4. Very pale transparent amber, 4 ounces; clarified linseed oil and oil of turpentine, of each 1 pint; as before. These varnishes are suitable for almost any purpose. (See *Negative Varnish.*)

Varnish, Bitumen. (See *Asphaltum.*)

Varnish, Black. 1. *Black Amber.* Amber, 1 pound; fuse, add hot drying oil, ½ pint; powdered black rosin and asphaltum, of each, 3 ounces; when properly incorporated and considerably cooled, add oil of turpentine, 1 pint.

2. *Black Japan.* Naples asphaltum, 2 pounds; dark gum anime, 5 ounces; fuse, add linseed oil, 2 quarts; boil, add dark gum amber, 7 ounces, previously fused and boiled with 1 pint linseed oil; add drier, boil for two hours, withdraw the heat, and thin down with oil of turpentine.

3. (P.) Dissolve caoutchouc, ½ drachm, in mineral naphtha, 10 ounces; add asphaltum, 4 ounces. Apply heat if necessary.

4. *Armstrong's.* (P.) Break up into small particles, black sealing-wax, and pour on it a sufficient quantity of spirits of wine to make the requisite thickness; place the vessel containing the ingredients in hot water, and stir occasionally with a glass rod; in a short time the sealing-wax will be melted, and the varnish ready for use. By mixing red sealing-wax with it you obtain the rich brown of albumen prints.

5. (P.) In 1 pint of asphaltum varnish melt and thoroughly incorporate ½ ounce best white wax.

6. (P.) Make lamp-black into a paste with turpentine, and dissolve it to the required consistence as required. This is the *stopping-out* varnish of the engraver.

Varnish, Collodion Transfer. (See *Transfer Varnish.*)

Varnish, Copal. 1. (P.) Oil of turpentine, 1 pint; set the bottle in a water-bath, and add, in small portions at a time, 3 ounces of powdered copal that has been previously melted by a gentle heat and dropped into water; in a few days decant the clear part; it dries slowly, but is very pale and durable.

2. Pale, hard copal, 2 pounds; fuse, add hot drying oil, 1 pint; boil in hot water bath, and thin with oil of turpentine, 3 pints. Very pale, dries hard in twelve to twenty-four hours. Used for paintings.

3. Clearest and palest African copal, 8 pounds; fuse, add hot and pale drying oil, 2 gallons; boil till it strings strongly, cool a little, and thin with hot rectified oil of turpentine, 3 gallons, and immediately strain into the store can. Very fine; used for pictures.

4. Coarsely powdered copal and glass, of each, 4 ounces; alcohol at 90°, 1 pint; camphor, ½ ounce; heat it in a water-bath so that the bubbles may be counted as they rise, observing frequently to stir the mixture: when cold decant the clear portion.

Varnish, Crystal. 1. (P.) Genuine pale Canada balsam and rectified oil of turpentine, equal parts; mix, place the bottle in warm water, agitate well, set it aside in a moderately warm place, and in a week pour off the clear portion. Used for maps, prints, drawings, and other articles of paper, and also to prepare tracing-paper and to transfer engravings.

2. Mastic, 3 ounces; alcohol, 1 pint; dissolve.

Varnish, Dammar. (P.) (See *Dammar Varnish.*)

Varnish, Etching. 1. *Lawrence's* white wax, 2 ounces; black and Burgundy pitch, of each, ½ ounce; melt together, add, by degrees, powdered asphaltum, 2 ounces; and boil until a drop taken out on a plate will break when cold by being doubled two or three times between the fingers; it must then be poured into warm water and made into balls for use.

2. *Callot's Hard.* Linseed oil and mastic, of each, 4 ounces; melt together.

3. *Callot's Soft.* Linseed oil, 4 ounces; gum benzoin and white wax, of each, ½ ounce; boil down one-third.

Varnish, Flexible. 1. India-rubber in shavings, 1 ounce; mineral naphtha, 2 pounds; digest at a gentle heat in a close vessel until dissolved; then strain.

2. India rubber, 1 ounce; drying oil, 1 quart; dissolve by as little heat as possible, and stir constantly; then strain.

3. Linseed oil, 1 gallon; dried with copperas and sugar of lead, of each 3 ounces; litharge, 8 ounces; boil with constant agitation until it strings well, then cool slowly, and decant the clear portion when settled. If too thick, thin it with quick-drying lin-

seed oil. All the above are used for balloons, gas-bags, etc.

Varnish for Gilded Articles. Gum-lac in grains, gamboge, dragon's blood, and annotto, of each 12½ ounces; saffron, 3¼ ounces; each resin must be dissolved separately in 5 pints of alcohol at 90°, and two separate tinctures must be made with the dragon's blood and annotto in a like quantity of spirit, and a proper proportion of each mixed together to produce the required shade.

Varnish, Italian. 1. Boil Scio turpentine till brittle, powder, and dissolve in oil of turpentine.

2. Canada balsam and clear white resin, of each 6 ounces; oil of turpentine, 1 quart; dissolve. Used for prints, etc.

Varnish, Lac. 1. Seed lac, 8 ounces; alcohol, 1 quart; digest in a close vessel in a warm situation for three or four days, then decant and strain.

2. Substitute lac bleached by chlorine for seed lac. Both are very tough, hard and durable; the last almost colorless. Used for pictures, metal, wood, or leather.

Varnish, Mastic. 1. Very pale and picked gum mastic, 5 pounds; glass pounded as small as barley, and well washed and dried, 2½ pounds; rectified turpentine, 2 gallons; put them into a clean 4-gallon stone or tin bottle, cork up securely, and keep it rolling backward and forward on a table pretty smartly for at least four hours; when, if the gum is all dissolved, the varnish may be decanted, strained through muslin into another bottle, and allowed to settle. It should be kept for six or nine months before use, as it gets tougher and clearer.

2. Mastic, 8 pounds; turpentine, 4 gallons; dissolve by gentle heat, and add pale turpentine varnish, ½ gallon.

3. Gum mastic, 6 ounces; oil of turpentine, 1 quart; dissolve. Used for pictures, etc. When good, it is tough, hard, brilliant, and colorless. Should it get *chilled*, 1 pound of well-washed silicious sand should be made moderately hot, and added to each gallon, which must then be agitated for five minutes, and afterward allowed to settle.

Varnish, Negative. 1. (P.) Dissolve shellac in 95 per cent. alcohol.

2. (P.) *Borin's.* Into 3½ ounces alcohol pour 3 drachms oil of lavender; add to this 80 grains of gum-lac; dissolve in hot-water bath and filter. In a well-stoppered bottle place 77 grains of powdered amber, mixed with broken glass to divide it, and 8½ drachms of chloroform; leave the mixture to digest for several days, shaking it occasionally. Then, finally, take 2 parts of the lac solution, and 1 part of the amber solution, mix them well and filter.

3. (P.) *Maddison's.* Take bleached shellac, 1 ounce; gum benzoin, 3 drachms; gum juniper, 1 drachm, or less; and soda borax, 1 drachm. Powder and dry them, and dissolve in alcohol of sp. gr. 0.800 to the proper consistency; filter.

4. (P.) *Monckhoven's.* Place in a flask, alcohol, 1 quart; white stick lac, 3 ounces; picked sandarac, 3 drachms. Raise the temperature of the flask slightly by plunging it into hot water, and in a few minutes the solution is effected, except a few filaments of insoluble lac; filter and it is ready for use.

5. (P.) Dissolve New Zealand gum, 1 ounce; gum shellac, ½ ounce; gum copal, ½ ounce; in sufficient 95° alcohol to form the proper consistence; filter. In using the above five varnishes the negative must be first slightly *warmed*. The following can be applied *cold*.

6. (P.) Methylated spirit, 1 ounce; gum-thus, 10 grains; gum sandarac, 15 grains; dissolve and filter through sponge.

7. Pulverize a sufficient quantity of pure amber for your purpose, place it in a closely covered vessel and gradually heat it up to 570°. A quantity of white vapor becomes disengaged, which is allowed to pass off, and the amber gradually softens, melts, and bubbles, when the vessel is to be removed from the fire, and the mass allowed to cool. This modified amber is extremely soluble in benzole and chloroform, and is to be dissolved in the proportion of from 40 to 50 grains to the fluidounce. With benzole a brownish varnish is obtained, but after drying it is very brilliant and clear, and it is almost impossible to tell which side of the plate has been varnished. Chloroform may be used as the solvent, but it is more costly, and the varnish is more brittle.

Varnish, Positive-Paper. (P.) White wax 60 parts; spirits of turpentine, 60 parts; fine copal varnish, 1½ to 3½ parts. Melt the wax in a gallipot, and, after removal from the fire, the turpentine and copal are added. Apply with a dabber of cotton-flannel, and polish with a second clean dabber.

Varnish, Shellac. (See *Negative Varnish.*)

Varnish, Waterproof. Take 2 quarts of boiled linseed oil; 2 quarts of raw linseed

oil; 1 ounce beeswax; simmer the whole well together for an hour; when cold it is ready for use. Apply to cotton, linen, silk, or any other fabric, in thin coats, making three or four applications as each dries. If desirable, color red with alkanet root, put into the oil while simmering.

Varnish, Wax. (P.) Pure white wax, 1 pound; melt with as gentle heat as possible, add warm spirits of wine, sp. gr. 0.830, 1 pint; mix perfectly and pour the liquid out on a cold porphyry slab; next grind it with a muller to a perfectly smooth paste, with the addition of more spirits as required; put the paste into a marble mortar; make an emulsion with water, 3½ pints, gradually added, and strain through muslin. Used as a varnish for paintings and positive photographic process. When dry a hot iron is passed over it to fuse it and render it transparent.

Varnish, White Cement. Gum copal pulverized in a mortar, adding spirits of turpentine gradually, to dissolve the gum to the desired consistence; about as thick as Canada balsam will be found the most effective.

Varnish, Zapon. Used by Dr. C. L. Mitchell. One need not warm the plate if the room is at 70° F., and a very hard, tough film is secured. Dissolve 15 grains of pyroxylin in 1½ ounces amyl acetate; shake frequently and let stand a few days. Pour on a thick pool in the centre of the plate and spread with a brush.

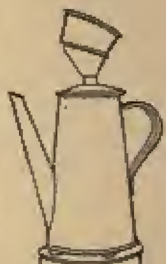
Varnishing. There is nothing more annoying to the photographer than the destruction of a fine negative by bad varnish. Above we have endeavored to give a list of the best varnishes for the various purposes for which they are used in photography. Those marked P are such as can only be applied to glass negatives, collodion positives, or paper proofs. Those not designated may be applied, in all cases, with a brush to paintings, engravings, wood, etc., as noticed under each head. In applying a varnish containing shellac, it is necessary to slightly warm the plate before pouring it on, otherwise it will dry white and opaque and the negative will be destroyed; and it should be placed in a warm place, either in the sun or near the fire, to dry, carefully shielded from dust. After warming the plate (and to make success more certain, you may warm the varnish by placing the bottle in warm water for a few minutes) take it by one corner, pour sufficient varnish on one corner to cover the plate, and then flow it across the plate to the opposite corner and then down to the lower end and off; draining back into the bottle in the same manner as for applying the collodion. This must be done as rapidly as possible, that the plate may not get cold before it is set up to dry and the varnish chilled.

Varnish Cup. A convenient article for keeping varnish clean is made as follows: A is a toy teapot, C a small tin funnel made to fit neatly in the top of the teapot; B a strip of tin covering about half of the top of the funnel. In using, pour from the spout and drain the plate into the funnel, in which some cotton has been placed.

FIG. 226.

Varnish Pot. Used for varnishing negatives. By means of a funnel on top, the surplus varnish poured upon the plate is filtered each time without spilling. A piece of cotton is placed in the funnel to serve as a filter.

FIG. 227.



Vaseline. Product of distillation of petroleum; a fatty mass of salve consistence. Used for making paper negatives transparent, also paper positives which are to be colored from the back (chromo-photography).

Vegetable Acid. Wood vinegar; pyroligneous acid; product of the dry distillation of wood. Its properties are those of common vinegar.

Vegetable Alkaloids. The vegetable compounds to which are given this title are possessed of an alkaline reaction, and are composed of oxygen, hydrogen, carbon, and nitrogen. They generally exist in the plants producing them in combination with an acid; are partially soluble in water and cold alcohol, but are very soluble in boiling alcohol. They generally combine with acids and form distinct salts, which are more soluble than the natural compounds or the pure alkali itself.

Vegetable Parchment is made by putting unsized paper into sulphuric acid mixed with a little water, and, after a few seconds, washing it thoroughly.

Veiled Negatives, To Clear. Prepare the following mixture: Glycerine and water, equal parts, which has been dissolved in cold hyposulphite of soda to saturation (40–50 to 100). This mixture is spread with a brush over the yellow negative, then the plate is left on a plane surface protected from heat and dust. According to the intensity of the coloration of the negative, the yellow tint invariably disappears in a longer or shorter time, which may vary from one to twenty-four hours. The negative is afterward washed in the ordinary manner. It is here the *nascent sulphurous* acid which acts on account of oxidation of the hyposulphite coming in contact with the air.

The method given above has before been recommended, but with a solution of hyposulphite in plain water, but it was found that the too rapid evaporation of the water gave to the surface of the gelatine incrustations of hyposulphite. The glycerine has precisely for its object to increase the proportion of dissolved hyposulphite and to prevent crystallization, even after a very long time. By this process negatives may be cleared that were so yellow that it was hardly possible to see the image, and which had been dry for more than two years.

Veneers, Photographic. In the application of photographs to cabinet-ware, Mr. J. K. France has patented the use of a substance that he calls "pyralin, or some other compound of pyroxylin." The print is fixed by means of alcohol. It is applied to the wood to be decorated, and the surface polished by pressure on a metallic plate, or by other means. This invention has for its principal object the veneering of furniture.

Venice Turpentine. A variety of commercial turpentine obtained from the larches of the Tyrol. Used as a solvent for varnishes. It has a peculiar resinous quality.

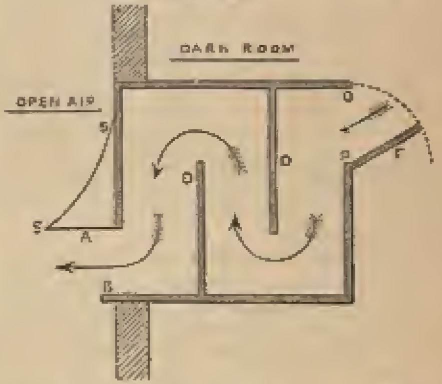
Ventilation. The proper ventilation of the studio and dark-room is essential to the comfort of the photographer and his patrons, and has a direct bearing upon success in work. The best way to ventilate the dark-room is to arrange the windows and doors so that a current of fresh air may pass through the room after the development of a plate, or at the convenience of the worker. Failing this arrangement an open grating should be fixed in the top of the door and protected by an upward flaring opaque screen to prevent access of light.

Mr. J. R. Hanna thus describes his system of ventilating the studio:

"Perfect ventilation is obtained by leaving open a space of about twelve inches on each side of the ridge of the roof, the covering over which space is raised about four inches above the main roof, and overlaps several inches, so as to prevent the rain from coming in during stormy weather. On the inside of the gallery, for a width of about two feet, the centre of the ceiling is composed of narrow laths about two inches apart and running the whole length. A sliding sash eight feet by six feet, running in a groove level with the floor, completes the system."

Ventilation, as applied to a photographic dark-room, consists in any common-sense

FIG. 228.

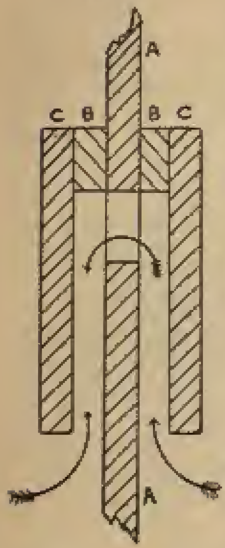


method of securing a circulation of fresh air. The diagram represents the method adopted by well-known studios, the arrows indicating the direction of the current from the entrance of the room to the open air. As poisonous fumes descend, a system of floor ventilation should always be secured.

Ventilator. It is advisable to fix one at each end of the room—the first near the floor, preferably under the sink, for the inlet of fresh air; the other near the roof, for the outlet of exhausted or heated air. A horizontal opening is cut in the wall, A (Fig. 229), from 12 to 24 inches in length, and 3 or 4 inches deep. Directly over the opening, at

each side of the partition, is fastened a strip of wood, B, an inch or more thick, about 2 inches wide, and the length of the opening. To these strips are screwed boards, C, not less than a foot wide. All that now remains to be done is to fix strips at each end, so that the air and light can only enter at the bottom, the former following the direction of the arrows, while the light finds some little difficulty in turning the corners. Dust may be entirely excluded by gluing over the opening, at the inside, a piece of fine gauze.

FIG. 229.



Vergara Films. Gelatine films mixed with a bichromate and exposed to light until brown, then decolorized with sulphurous acid. They are very tough, transparent, and insoluble; used as the base of sensitive gelatino-bromide films for film photography.

Vernier's Fixing Process. The paper being prepared with chloride of silver in the usual way, and placed in the pressure-frame, the exposure is prolonged until the shadows of the picture are very deeply printed, so as to have all the details in the light parts. Five or ten positives are printed and then they are all completely immersed in a large quantity of weak solution of salt. In a few hours the water is changed, and in the evening they may be fixed. For this purpose a solution of gold in sufficient quantity to cover the pictures is poured into a flat dish, and one of the prints laid in it; the dish is now gently tilted backward and forward until the picture is sufficiently toned down, and then it must be well washed in abundance of clean water. The other pictures are now to be treated in the same manner, and then the whole are to be allowed to soak all night in a large tank of water. They are afterward to be fixed by soaking for at least half an hour in a solution of hyposulphite of soda (1 part to 15), and then for the same time in a solution of an alkali (1 part to 10); afterward washed as usual.

Vertical Attachment. An attachment used with the magic lantern, for projecting upon the screen chemical action, liquids, living and other objects which cannot be shown in a horizontal position.

FIG. 230.

Victoria Photographs. This style of portrait is produced by simply painting out the background in the negative with asphaltum or other black varnish, being careful to distinctly preserve the outlines of the figure. These backgrounds may be more or less shaded off to give a modified vignette appearance. This, however, requires great skill. They are printed in the usual way, but care must be taken to prevent spotting, for the backgrounds of the finished pictures being white, the spots will spoil the prints.

Vest Camera. An invention of Mr. R. D. Gray. It is a dark chamber containing an instantaneous shutter, and the apparatus for working it, with the means of holding a circular sensitized plate in place, capable of receiving six exposures. Outside, at one edge, the tiny lens, looking like a horn vest-button, is placed, and at the centre is a knob with a dial-hand, by means of which the exposures are numbered—one to six—as made. Each exposure secures a picture 1¾ inches in diameter. When "loaded," the camera is hidden under the vest, the lens protruding through the button-hole. From one edge leads a string downward; the pulling of this string causes an exposure to be made.

View Camera. A camera used especially for outdoor photography. Made in endless variety and with many ingenious attachments, for use upon a tripod and when held in the hand.

View-Meter. Any instrument used to show the amount of a view included by the lens upon the ground-glass, without the trouble of setting up a camera. Mr. E. J. Wall, in his *Dictionary*, gives the subjoined description: "Obtain two brass tubes 2½ inches long and 1¼ inches in diameter, one made to slide within the other. (Fig. 231.)

Fig. 231.

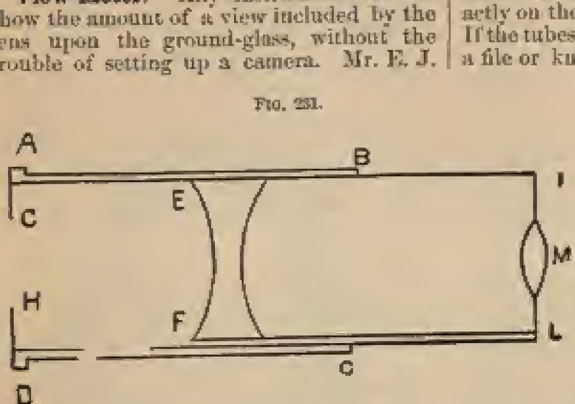
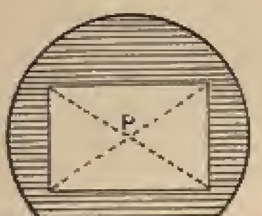


Fig. 232.



A B C D, a brass tube bearing a cap at one end in which is an opening, G H, having a size proportionate to plate used—for a plate 4¼ x 6½ the opening may be 2⅜ x 1⅝ inches. E F I L slides inside A B C D, having at one end a double concave lens, E F, of 1½ inches focus, and at the other end a double convex lens, M, of 3 inches focus. When the eye is applied to the convex lens, the picture is seen in miniature. P (Fig. 232) shows the front view of the cap of the instrument. To use this meter it must be adjusted to the lens with which it will be worked. To do this, erect the camera, focus carefully, and mark two prominent objects on the edges of the ground-glass. Now adjust the view-meter tubes until the marked objects are exactly on the edges of the field of view in that. If the tubes of the meter are now marked with a file or knife at the exact point at which the inner tube was pulled in or out, that will always include the amount of view included by the lens. If two fine wires are fixed across the cap, as shown by the dotted lines in P, the meter will serve as a view-finder as well. If a circle of blue glass is placed inside the cap the meter will also serve to indicate the exposure required, as this screen will cut off all the rays of light except those which affect the photographic plate.

View Lens. An objective employed especially for outdoor photography. The variety is endless. (Consult the INDEX.)

View Angles, Table of. By REV. CLARENCE E. WOODMAN, Ph.D. (Reprinted from the *Photographic Times.*)

Divide the Base of the Plate by the Equivalent Focus of the Lens.

If the quot'nt is	The angle is	If the quot'nt is	The angle is	If the quot'nt is	The angle is
0.282	16°	0.748	41°	1.3	66°
0.3	17	0.768	42	1.32	67
0.317	18	0.788	43	1.35	68
0.335	19	0.808	44	1.375	69
0.353	20	0.828	45	1.4	70
0.37	21	0.849	46	1.427	71
0.389	22	0.87	47	1.45	72
0.407	23	0.89	48	1.48	73
0.425	24	0.911	49	1.5	74
0.443	25	0.933	50	1.53	75
0.462	26	0.954	51	1.56	76
0.48	27	0.975	52	1.59	77
0.5	28	1.00	53	1.62	78
0.517	29	1.02	54	1.649	79
0.536	30	1.041	55	1.678	80
0.555	31	1.063	56	1.7	81
0.573	32	1.086	57	1.739	82
0.592	33	1.108	58	1.769	83
0.611	34	1.132	59	1.8	84
0.631	35	1.155	60	1.831	85
0.65	36	1.178	61	1.865	86
0.67	37	1.2	62	1.898	87
0.689	38	1.225	63	1.931	88
0.708	39	1.25	64	1.965	89
0.728	40	1.274	65	2.00	90

Example.—Given a lens of 13 inches equivalent focus, required the angle included by it on plates respectively 3¼×4¼, 4¼×6½, 6½×8½, 8×10, 10×12, and 11×14.

1. Dividing 4.25 by 13, we have as quotient 0.327—

midway between the decimals 0.317 and 0.335 of our table; therefore the required angle is 18° 30′. Similarly,

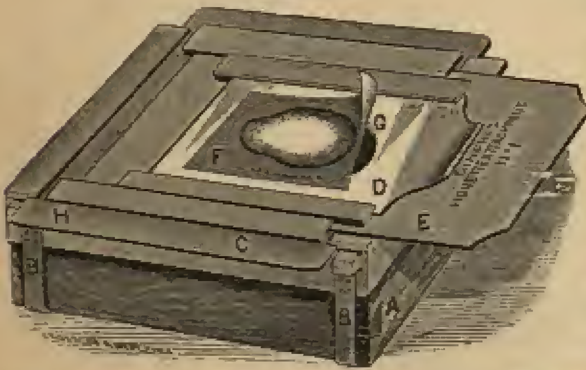
2.	6.5	÷	13	=	0.5	corresponding to	28°
3.	8.5	÷	13	=	0.654	"	" 36
4.	10	÷	13	=	0.77	"	" 42½
5.	12	÷	13	=	0.923	"	" 49½
	14	÷	13	=	1.08	"	" 57

View-Finder. Any instrument by which the object photographed may be viewed without erecting the camera or during the exposure. By means of such an instrument when moving objects are being photographed, the right moment for exposure may be determined at a glance, together with every detail included in the picture. View-finders generally take the form of a miniature camera or box with lens and ground-glass, fitted to the front of the camera proper. Many descriptions of finders may be seen and compared by consulting the catalogues of supply dealers.

Vignette. A picture whose background gradually blends off into white. Vignettes are produced by printing under a vignetting attachment to the printing-frame. Portraits may also be vignetted direct in the camera during exposure by an arrangement placed before the objective, or attached to the back lens in the camera. (See further the articles following.)

Vignette Attachment. The diagram represents one of many designs for attach-

FIG. 233.



ment to the printing-frame for printing vignettes. Waymouth's vignette papers (see F) are used with this contrivance. The parts D G and E are made to slide for adjustability. In the framework, H C and A B B represent the printing-frame.

Vignette Glass. A sheet of colored glass used for producing vignette miniatures or portraits. To make these glasses, proceed as follows: (1) Take a piece of white paper, about the size of a double crown, upon which gum an oval piece of dead-black paper the size and proportion required, and with a dense collodion produce a negative of this as follows: Move the paper backward and forward from and toward the lens, and after sufficient exposure, develop and fix as usual. Copies of different sizes required may be thus produced with excellent gradations. After drying, varnish. (2) Take a "matt" of convenient size and shape and lay it upon a piece of silvered paper of corresponding size, and then expose to light. During the exposure the matt is kept in motion in such a way as to obtain an oval, black image, gradually lightening outward into the white paper. The print is toned and fixed in the ordinary way. From this print an intense negative is now to be made; this negative when varnished becomes the vignette glass. The size may be increased or diminished by varying the distance of the camera. (3) First, provide yourself with some pieces of ruby-tinted glass; secondly, a small bottle of fluoric acid. Take a small dabber of cotton-wool wrapped around a stick; dip the wool in the acid, then rub lightly in a circular direction on the stained side of the glass till your object is accomplished. (4) Place an oval piece of white paper upon a sheet of black paper and take a picture of it precisely as directed in 2. To print from this, first place this vignette glass upon the sensitive paper and print the depth required; remove the vignette glass, and upon the unchanged white centre place the negative, and having replaced the vignette glass, which protects the margin, proceed to print. This gives a vignette picture on a tinted ground, whilst all the whites in the portrait itself are kept pure and clean.

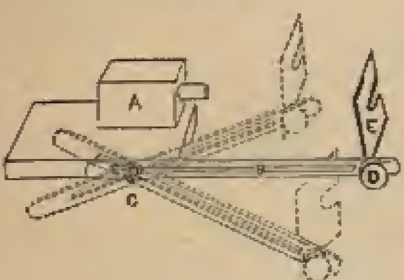
Vignette Paper. A device of Mr. Waymouth. It consists of a lithograph design of non-actinic color gradated upon fine tissue paper, and used for placing over the nega-

tive during printing for the purpose of securing vignettes. (Fig. 234.)

FIG. 234.

Vignetting in the Camera. A, represents the camera box—moved to one side of the top of the stand in order to delineate the other parts more easily. B is a strip of one-half-inch walnut, of any proper length, with a slot in it nearly the whole length. E is a

FIG. 235.



piece of stiff cardboard, cut to the shape in the drawing, and attached to the end of the strip B by the screw-knob D, by means of which it may be turned at any angle desired. The strip B is fastened to one side of the top of the camera-stand by means of another screw-knob at C, on which it is also worked back and forth. It also enables us to control the whole apparatus, and by loosening it we may move it up or down as shown by the dotted lines. If you wish to prevent an abrupt line, work the card E back and forth gently during exposure, by means of the knob D.

Vignetting Arrangement. Introduced by C. Triebel, in Vienna, consisting of a frame covered with brown or black gauze, with an opening in the middle. Serves in printing portraits (busts) with white vignette effect.

Vignetting-Board. A piece of cardboard, tin, or other suitable material, in the middle of which an oval or pear-shaped opening has been cut, and which is placed upon the printing-frame during exposure (in diffused light). Tissue paper placed over the opening improves the result.

Violet Prints. May be obtained by the process of *photo-tincture*, or the *carbon process*. Blue prints may be toned to a dark-violet color by treating them first with a solution of 1 part of caustic potassium (potassium hydrate) in 300 parts of water, and afterward with the solution:

90 per cent. Alcohol	25 parts.
Water	30 "
Gallic Acid	4 "

Violet Rays. The upper rays of light formed upon the spectrum by the decomposition of light by the prism. (See *Light*.)

Violet Tints. The peculiar tints given by French photographers to their prints. The French violet tints, when sufficiently neutral, and not dead, or inky, or sooty, are the most agreeable yet obtained. These prints are, in general, very rich in color, and they possess sufficient depth and transparency, without any perceptible glaze, beyond that of the paper itself, when submitted to strong pressure under rollers. They resemble, therefore, most exquisite engravings, but with this advantage, that the color of the lights is perfectly charming and peculiar, and totally unlike any of the tints which can be obtained by the use of any of the old hypo baths, which seem to act by the precipitation of sulphur. The following is the mode of obtaining these tints: The salting solution is composed of

Hydrochlorate of Ammonia	1 ounce.
Sugar Candy	1 "
Distilled Water	20 ounces.

Float on this for five minutes, and then hang up to dry. Should the solution redden litmus-paper, a few drops of aqua ammoniæ must be added. The sensitive solution is composed of

Nitrate of Silver	$1\frac{1}{4}$ ounces.
Distilled Water	10 "

Float on this for five minutes, and then hang up to dry. The printing is to be of the usual strength. On removal from the pressure-frame, immerse the proof in rain-water to which a few drops of ammonia have been added; then wash it well in an abundance of water, changed several times. Afterward place it in the coloring bath, which is composed of

Sel d'Or (not Chloride of Gold)	15 grains.
Distilled Water	30 ounces.
Pure Hydrochloric Acid . . .	2 drachms.

Allow it to remain in this until it has acquired a deep purple tint in the shadows, and an agreeable tone of gray or cream color in the lights; this will occupy a few minutes only. The changes of tint may be observed in a sort of half-light. Then remove it, and wash it well in an abundance of water; change five or six times, and then place it in the fixing-bath, which is composed of hyposulphite of soda, 6 ounces to 1 quart of distilled water. Leave it in this until the deep purple tint shall have become slightly neutralized; about one hour will be the extreme limit. Then wash it as usual to remove all traces of hyposulphite, and leave it to soak for twenty-four hours in water. On removal from the water, press it between folds of blotting-paper to remove the surface moisture, and then apply immediately, with a brush, albumen diluted with an equal quantity of water. Then hang up to dry. The albumen applied in this manner *preserves the depth of tone without imparting a glaze to the paper.* Without it, the proof on becoming dry would have a dead appearance, which this entirely prevents. These prints may be mounted on glass in the following manner: Float the print, face downward, upon albumen diluted with one-fourth part of its bulk of water. (Of course a print is meant which has not been previously albumenized, and which has been well washed and dried after fixing.) Let it remain on this several minutes. Whilst in this bath, take the sheet of plate glass upon which it is intended to mount it (and which is to form subsequently the glass of its frame), and cover it completely with a thick coat of albumen. Level it exactly, and then apply the albumenized face of the paper to the glass. When dry the print will adhere firmly to the glass, and will then look as well as it did in the water. It may then be placed in its frame.—*Sutton.*

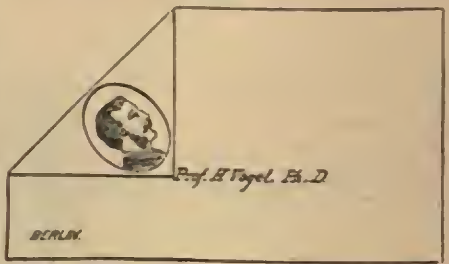
Virgin Wax. Pure beeswax—generally white and translucent. It is used in photography for waxing paper, to give the negative transparency, and also as a sizing previous to its preparation with the nitrate of silver. It is one of the best sizings, without at the same time dispensing with the use of the others. It places the paper in a state perfectly adapted to receive the preparations, and admits of its receiving the action without alteration or injury. (See *Wax.*)

Virtual Angle. The point from which rays, having been rendered divergent by reflection or refraction, appear to issue.

Virtual Image. If the light from one object reaches the eye in two distinct directions, the effect is the same as if there were two objects. A reflection such as this, that appears like an image but is not one, is called a virtual image.

Visiting-Card. A card the size of a lady's visiting-card, containing the name and address of the owner in the usual manner, has

FIG. 236.



the top left-hand corner turned down—or, rather, ostensibly turned down—to receive a small medallion portrait on the triangular piece formed by the fold of the corner. The medallion is oval, about the size of a shilling, or less, and contains, of course, just the head and bust. The turned-down corner, as we explained, does not actually exist; but the effect is gained by cutting off the top

left-hand corner, and printing on the card the lines, forming a right-angled triangle, which the piece would form if turned down. At first glance, the effect is given of an actually turned-down corner. The size of the triangular space formed is just sufficient for such a medallion as described, the base and upright of the triangle each being an inch and three-quarters long.

Visual Angle. The angle under which an object is seen; the angle formed at the eye by the rays of light coming from the extremities of the object.

Visual Focus. That point of the focus of a lens visible to the eye.

Visual Point. In perspective, a point in the horizontal line in which the visual rays unite.

Visual Rays. A line of light supposed to come from a point of the object to the eye.

Vitriol. Blue vitriol, sulphate of copper, $CuSO_4$. Green vitriol, sulphate of iron (which see). White vitriol, sulphate of zinc, $ZnSO_4$.

Vitriol, Oil of. The name commonly given to commercial sulphuric acid. A heavy, oily liquid with a gray tinge; used in photography in making pyroxylin and for a variety of other purposes.

Volatile Alkali. A term sometimes used to designate ammonia, from its propensity to escape from solution.

Volatilize. To render volatile; to cause to exhale or evaporate; to cause to pass off in vapor or invisible effluvia, and to rise and float in the air.

Volume. Dimension; space occupied by a body; compass; bulk.

Vowel Sounds, To Photograph. At an International Congress of Physiology at Liége, Professor Hermann demonstrated his method of photographing the sounds of the vowels. The vowels were sung out before one of Edison's phonographs. Immediately afterward they were reproduced very slowly, and the vibrations recorded by microphone. The latter was furnished with a mirror, which reflected the light of an electric light upon a registering cylinder, covered with sensitized paper, and protected by another cylinder with a small opening which gave passage to the rays of light from a reflector. By this means were obtained very distinct photographic traces, and the constancy was remarkable for the different vowels.

W.

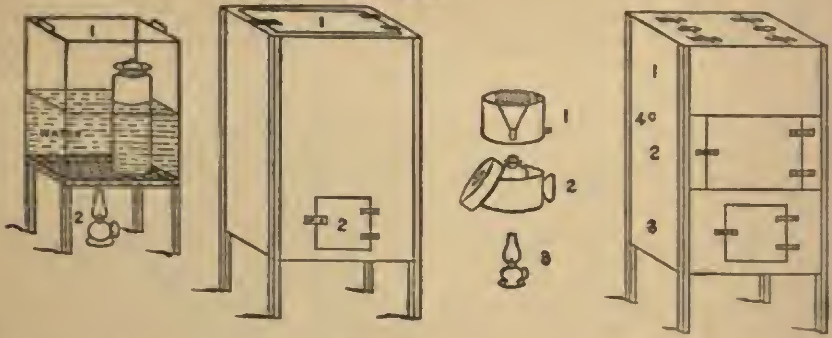
Walking-Stick Stand. A camera tripod which, when folded up, resembles a walking-stick.

Wallis' Photo-Engraving Process. This is a patented process which does not bid very fair for practical results, but may be recorded as one of the many ideas to which photography has given birth, and which by varied modifications has led to modern processes. The patentee claims, first, the method or methods described (in the specifications) of preparing photographs for the purpose of impressing or engraving the same, in or upon metallic surfaces, to produce printing or embossing surfaces, by the use of mixtures or compositions consisting essentially of purely hard granular substances, and softer bodies of mineral or vegetable origin, mixed with some gelatinous body, such as gum-arabic; which mixtures constitute drawing materials which will flow easily from a pen or brush, and which, when dry, will form a substance sufficiently hard to impress metallic plates when subjected to strong pressure thereon. Secondly, the use of bichromate of ammonium, or other soluble chromic salt, as a fixing constituent in mixtures or compositions to be used for preparing photographic pictures, to be afterward impressed or engraved on metal plates as described. Thirdly, the production of a tint upon a metal surface when impressed with paper or other material, upon which the photograph has been made, and the treatment therewith with scraper and burnisher in the manner of a mezzotint engraving, for the production of lights and shades when printed from in the manner of a copper-plate. Fourthly, the method of re-damping photographs which have been previously treated, as before described, for the purpose of supplementing the same granular powders. Fifthly, the general arrangement or combination of parts of the machinery described.

Warming-Box for Emulsion. Mr. S. L. Platt, in *Wilson's Photographic Magazine*, says: "I send you a sketch of my cooking and warming-box. The heat from the lamp passes all around an inside can containing water. Place a wire net in the bottom of the can to raise the jar about one inch; the heat will then be even. I always prepare the emulsion the evening before using, and

place it to filter in my warming-box, made as engraved. Pour the emulsion in, and allow it to drip into the bottle contained in the warm-water can, No. 2. Place a small lamp in at No. 3, and keep it burning so that the heat is kept at 100° till after the flowing

FIG. 237.



is ended. The flowing I do with my flowing apparatus, which connects with the emulsion bottle by means of a small rubber hose passing into the heating-box through the hole in the side at No. 4."

Warming-Pans for the Carbon Process. In developing carbon prints by the use of hot

FIG. 238.

water, two or more pans are needed to be used close together. The application of heat is made by a metal stove underneath, as shown in Fig. 238.

Warm Tones on Bromide Paper. (See *Bromide Paper*, and *Toning*.)

Warnerke's Process. A modification of the emulsion process, based upon the fact that the image produced on a gelatine film is insoluble in hot water if developed by the alkaline pyro process. In this method gelatino-bromide emulsion is spread upon paper instead of upon glass. The emulsion must contain no alum or analogous material—this is an essential. After exposure in the camera the image is developed with pyrogallic acid in the ordinary manner. It may afterward be fixed or not, for it makes very little difference in the end. The negative thus far completed is squeegeed, face downward, on to a glass plate, either collodionized or not, and then placed in warm water. In a short time the paper comes off, leaving the film adherent to the glass. By the continued action of the warm water the gelatine which has not been affected by the joint action of light and developer, dissolves away. In the end the image consists of the reduced silver in different thicknesses of gelatine, while the deepest shadows are simply bare glass. The negative can now be intensified to any required extent and by any method, one of the simplest being a solution of permanganate of potash. It will be seen that, as the shadows are free from gelatine, there is nothing to be stained. If the image, instead of requiring intensifi-

cation, is too dense, it may be reduced by using hotter water, precisely as in developing an over-exposed carbon print.

The negative thus obtained is reversed, and in that state is well adapted for collotype or other processes requiring a reversed image. If it be required for silver printing, the negative can be developed on a flexible support and then transferred to a glass plate, or the negative can be stripped from the glass upon which it received the second development on to a gelatine film.

One of the numerous applications of the Warnerke process, mentioned at the time of its introduction, is the production of carbon enlargements direct from the original, thus dispensing with both the transparency and the enlarged negative. In this case the pigment is added to the bromide emulsion, so that a "carbon tissue" is obtained, combined with the sensitiveness of bromide paper. The enlargement is made as with ordinary bromide paper, except that the image must be developed with pyrogallic acid; then it is squeegeed on to transfer paper, and developed with hot water as a carbon picture; thus an enlargement in pigment and silver is obtained, but the silver can afterward be removed, if thought desirable.

Warnerke's Sensitometer. An instrument devised by L. Warnerke to indicate the speed or relative sensitiveness of dry plates.

Washing. Particularly applied, in photography, to the washing of paper proofs. In all large cities, where water is abundant and is carried through buildings in a running stream, it is the practice to have large tanks into and from which the water is constantly running. Into these well-filled tanks the proofs are placed and allowed to remain for several hours. To guard against obnoxious matter which may be in the water, filters are attached to the supply-cock. This is undoubtedly the very best method of washing prints; but in towns and villages where the supply of water is limited, other methods have to be devised. A good plan for permanent galleries is to have a tank constructed near the ceiling of the room, connecting with the eaves-trough of the house by pipes and thus catch the rain-water as it falls.

This tank can be connected with the washing trough by means of another pipe, to the end of which should be attached a stopcock and filter. A waste-pipe, to carry off the water from the washing-trough just as fast as it runs in, must be placed in the bottom at the opposite end to that at which the water is supplied. When rain fails to supply, the tank can be filled with river-water. Instead of the tank a barrel or hogshead may be used. Where none of these methods can be made available, a large pan must be used, and the operator then proceeds as follows: First, let the print soak for fifteen or twenty minutes; change the water, and rinse well; again change the water, lay the print upon a slab of glass, and with a sponge sponge it thoroughly on both sides for twenty minutes or half an hour, changing the water several times; finally, rinse well in several waters, sponging occasionally with a fresh piece of sponge, until the final water gives no sweetish taste and none is perceptible to the tongue when touched to the margin of the print.

It is very essential that the print should be freed entirely from hyposulphite, and the washing should not be stopped until this is the case, which point is ascertained quite accurately by *tasting* as directed. Several machines for washing prints have been invented to insure running water, and also to increase the action of running water upon or in the print. (See *Automatic Washing Tank*.)

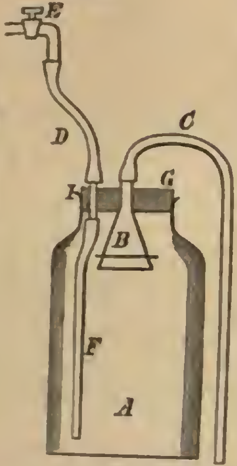
Washing Apparatus. Used for washing plates after coating with emulsion. It may be a metal box with wooden racks, which last should hold two plates, back to back, in each division. The washing proceeds more rapidly when the plates are uplifted and the water runs off underneath. The flow of water should be so arranged that the box is always full. To this an opening is made in one side near the bottom; to this is soldered a small lead pipe, which is bent almost at the top of the box in a bow and carried downward again. The water then must escape from below and inside always stand as high as the bend in the pipe.

Washing Jar for Emulsion. A pear-shaped bellied glass is covered at its narrow end with stout muslin to support the emulsion, and the whole is set in a roomy beaker as is seen in the illustration (Fig. 239). To change the water it is only necessary to lift the glass, when, by slightly agitating it, the water drains off. The beaker is then emp-

tied and refilled with water. It is the invention of Victor Schumann.

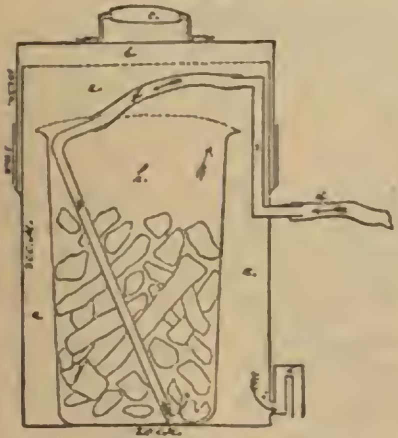
Fig. 239.

Fig. 240.



A second contrivance (see Fig. 240): The water is conducted to the bottom of the vessel by the tube *D F* and flows off through a funnel, *B*, which must be closed with silk. *C* is the outlet. *E* is the stopcock and *I* a glass tube connecting the parts of *D F*.

Fig. 241.

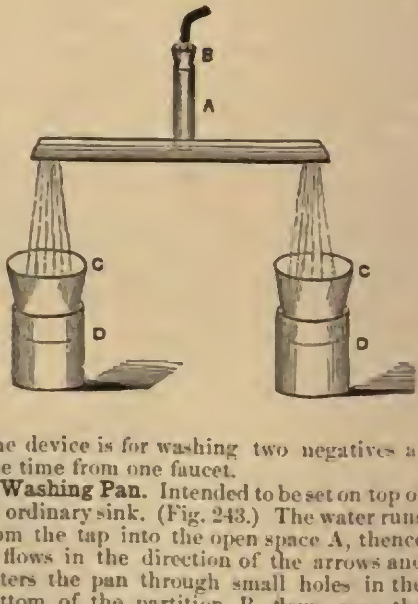


Washing Apparatus for Gelatine Emulsion. Made of strong sheet zinc. (Fig. 241) *a*, interior space of the apparatus; *b*, the cover; *c*, handle of cover; *d*, gum tube for ingress of water; *e*, stationary brass tube; *f*, gum tube; *g*, bent tube of glass; *h*, beaker glass containing the emulsion; *i*, tube for exit of water.

Emulsion is supposed to be washed until it contains no more than 1 per cent. of soluble bromide.

Washing Device for Negatives. A is a one-inch tube fitted to the water faucet by means of the cork B; C is a tin funnel for a neck, entering half-way into a large jar, D.

Fig. 242.

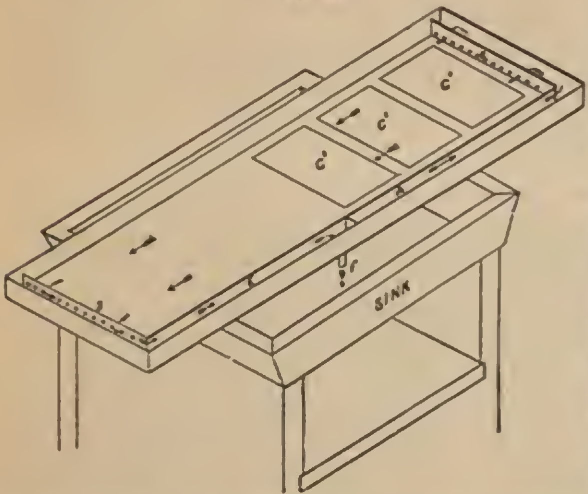


The device is for washing two negatives at one time from one faucet.

Washing Pan. Intended to be set on top of an ordinary sink. (Fig. 243.) The water runs from the tap into the open space A, thence it flows in the direction of the arrows and enters the pan through small holes in the bottom of the partition B, flows over the negative C to the partition D, when it flows out through small holes in the top of that partition into the channel E, and running out of the pan at F into the sink. The water flows in one sheet, without eddies, from B to D. This can be easily tested by dropping into the channel A some soluble aniline color. Plates fresh from the hypo are put near the end D, and when the pan is full, negative C[1] will be washed enough and can be removed and the other plates shoved up to make room for the next plate to be developed. If desired, alum can be put in a

little ridge across the pan between C^3 and C^2; it will be gradually dissolved and act on the negative toward D, but those on the other side will not be affected; or, if preferred, the alum can be put in the channel A.

FIG. 243.



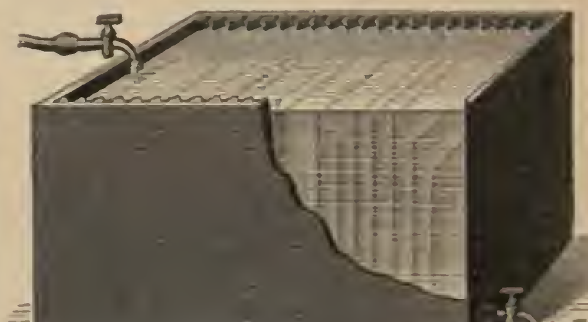
Washing Tank. Such as is used in photo-mechanical processes for washing the plate without exposure to the sun. It should be filled with water, covering the plates, and renewed if possible by a continuous current. (See Fig. 244.)

Wash-Out Engraving Process. A process for obtaining blocks for the printing press; inferior to the "swelled-gelatine" process which is largely used. This process is described in detail, too complicated to be inserted here, in *Photographic Mosaics*, 1890. For swelled-gelatine process see Wilkinson's *Photo-Engraving*, etc.

Wastes, To Save Photographic. The recovery of residues from photographic wastes is beyond the capabilities of most photographers. Every kind of waste should, however, be saved in a receptacle of some kind by the methods given below, and the product obtained sent periodically to a reliable firm making a specialty of recovering residues.

A. *Developer Drippings.* Enough protosulphate of iron remains in the drippings from the development of wet plates to precipitate the silver. What is needed, then, is to catch carefully what goes off the plate in a suitable vessel, and allow it to settle. Pour off the clear water *once a day.* This last is important, for when the water is allowed to remain for some days the recovery of the silver is more difficult, and the amount recovered is much less, owing to the large quantity of iron present. If left any length of time, test with common table-salt; if it show a precipitate, proceed as follows: A small quantity of salt in solution should be stirred into the drippings before the water is poured off, and until the water appears clear. Take time to do the work thoroughly. The precipitate is rich in *chloride of silver.* Add the salt gradually, stirring the solution until a precipitate no longer falls, which may

FIG. 244.



easily be determined by taking a sample of it in a tumbler or white bottle, holding it up to

the light when adding a little salt. Do not add too much, as an excess will dissolve the chloride. When the silver is all thrown down, pour in a little nitric, sulphuric, or muriatic acid, which will clear the solution; allow it to stand for about twenty-four hours, then draw off the clear water and you have the chloride on the bottom of the vessel.

B. *Fixing Solutions* are very rich in silver. They should be treated with sulphuret of potassium dissolved in water, adding it as long as a precipitate forms. The precipitate should be thrown on a plain muslin filter to allow the water to drain off. A filter may be readily constructed of common unbleached muslin, say a yard square, tying loops to the four corners, and hanging it up on sticks.

Many photographers are in the habit of precipitating their washing solutions with sheet zinc suspended therein. The action of zinc, however, is slow, and must be accelerated by acidifying the solution. Now it frequently happens that the fixing solution is allowed to run into the same vessel, and the hypo, being an alkali, suspends the action of the zinc. In the course of time a deposit is formed, but the happy possessors of the "mud" are sadly disappointed as to its value, since it is sometimes so poor as not to pay for the trouble of refining. All hypo fixing solutions may be treated together in this way. A large barrel is the best receptacle for them. Insert a spigot about six inches from the bottom. It has been found economical to use a large crock or stone jar —or it may be glass—for the negative fixing solution; you can use a dipper with it, or let a strong strip of glass remain in and across it at an angle to prevent the smaller plates from going flat to the bottom of the vessel. At intervals the solution may be emptied into the barrel. The precipitate which results is *sulphide of silver*.

C. *Impure Solutions and Used Baths.* Besides salt, muriatic acid, sulphuret of potassium, protosulphate of iron, or sheet copper may be used to precipitate silver from any solution rich in that metal; or the solution may be boiled to dryness, and the wastes sent to the refiner. The reasons are obvious: the freight is less, there is no loss from the breakage of bottles, and leakage is insured against. See instructions for saving print-washings (E). The same course may be followed here.

D. *Silvered Paper.* All prints should be trimmed before toning, as it saves gold; and besides, toned paper is of little value. Keep the untoned clippings and filters by themselves; do not throw sweepings, pieces of glass and spoiled ferrotype plates among them, as their bulk only decreases the real value. If you wish to burn the paper, free the fire from cinders and ashes, and proceed slowly, for a strong draught will carry many particles of silver through the flue. Every inch of silvered trimmings is valuable, and should be kept in a box separately. Do not tread them under foot and allow them to become mixed with dirt and grit and dust on the floor. Keep a cover on the box, and put nothing but clean, untoned paper trimmings into it.

E. *Print Washings* may be treated the same as A, only it is better to keep them separate. You save more than pays for the additional trouble. Add the salt gradually, and watch the effect. If precipitation is slow and the solution remains milky in appearance, the addition of a little of the protosulphate of iron solution is of service. Some workers prefer a mixed solution of salt and alum—say 12 ounces of each ingredient dissolved in 2 quarts of hot water—for a stock solution. Add this carefully, and not too much of it.

F. *Toning Solutions.* Precipitate these with protosulphate of iron, but be sure to have the solution "acid," as otherwise the iron will be precipitated and the gold will be lost. Old toning-baths and the precipitates which form when the toning-bath is being neutralized by bicarbonate of soda or other alkali, should be saved, and kept separate from any other wastes.

G. *Toned Paper Clippings.* In a small business it hardly pays to save these, but where the quantity used is large and fuel is cheap, it often does. Printers for the trade, publishers of photographs, and those whose business is large, have found the recovery of gold from these clippings well worth looking after.

H. *Old and Spoiled Dry Plates* are likewise worth taking care of. The emulsion can be best removed by soaking the plates in a strong hot solution of carbonate of soda (washing soda). When a quantity is collected, strain it through a muslin filter, allowing the solution to drain off. A stone jar is excellent for this work. After filtration the precipitate should be allowed to dry

spontaneously, when it is ready for the refiner.

I. *Barrels, Floors, and Old Hats.* It will be found that the wood of barrels which contained waste solutions for a number of years is strongly impregnated with silver, some barrels yielding as many as 30 ounces of metal; so when these are unfit for further use burn them.

The same is also true of the floors of long-used dark-rooms and of rooms where paper is silvered and drained and fixed. Old felt hats are used for developer drippings by some. These with the developer, skin fragments, and emulsions from dry plates, as well as blotters and filters, are all worth saving.

J. *Aristotype Paper Wastes* should be treated the same as other paper wastes (D). They may go together, but in everything like "waste" the *separate* plan is preferable.

K. *Finally, a Word or Two.* The end of all waste is silver and gold, if you strive to follow this advice. Dissolve the salt and iron before they are added to the waste solutions. A few drops of acid should be added to the iron solution before it is used. Any acid added to a cyanide solution will precipitate the silver. Have abundant air in circulation about you when you do this, for the fumes—*waste you!* Don't use sheet zinc for anything thereof.

Watch-Dial Pictures. Photography may be very effectively employed in the decoration of watch-dials for presentation purposes, and portraits executed in this manner are always attractive and add considerably to the photographer's exchequer and reputation. These transfers may be made in various ways, some preferring one and some another. One popular method is to sensitize with a collodion chloride emulsion a previously talc'd glass. When thoroughly dry print the reduced portrait thereon, using a suitable oval or other shaped mask, tone and fix in the usual way, and dry over a spirit lamp or spontaneously. The film is then softened with methylated spirit, and soaked in water acidified with a few drops to the ounce of acetic acid.

In this bath the film may be easily floated off, if gently manipulated with a camel's-hair brush. A sheet of paper is then passed beneath the film (while under water), and lifted out in contact. At this stage it is easy to cut out the portrait along the lines of the mask with a pair of small, sharp scissors.

Next, pass the portrait on its temporary support into a dish of plain water, where they will again separate. Take the watch-dial (previously albumenized) and pass it beneath the film in the water, and gently entice it into position by means of a camel's-hair brush, being careful to avoid air bubbles. Raise from the water-bath and allow to dry spontaneously. A coat of clear hard varnish over the whole dial completes the operation. Other methods will suggest themselves, including the much-neglected, though beautiful, carbon process, and the very simple transferrotype of the Eastman Company.

Clement J. Leaper's formula for collodio-chloride for printing out is most suitable for the purpose, and is as follows:

a. Alcohol, 1 oz.; Ether, 1 oz.; Pyroxylin, 12 grs.
b. Silver Nitrate, 60 grs.; Water, 1 dr.
c. Strontium Chloride, 64 grs.; Alcohol, 2 oz.
d. Citric Acid, 64 grs.; Alcohol, 2 oz.

Mix 30 minims *b* with the whole of *a*, add a drachm of *c* and half a drachm of *d*. Shake well after each addition, and coat at once.

If the collodion film be toned with platinum instead of gold, it may, when transferred, be *burnt in* by any one using a muffled furnace. This gives an absolutely imperishable portrait within the body of the enamel.—*W. Ethelbert Henry.*

Water. The true constitution of water was not discovered till about the middle of the last century, when the Hon. Mr. Cavendish proved that this liquid was a compound of hydrogen and oxygen. These gases exist in water in the proportion of 1 to 8 by weight, or 2 to 1 by volume; the specific gravity of hydrogen being to that of oxygen as 1 to 16. When water is made part of the voltaic circuit, it is resolved into 2 measures of hydrogen and 1 measure of oxygen gas; and if the gases thus obtained be mixed, and exploded by the electric spark, they again combine and produce their own weight of pure water. The composition of water is thus clearly demonstrated by analysis and synthesis. In the production of water from its constituent gases, there is a condensation of nearly 2000 volumes into one, thus showing the wonderful effects of chemical combination. One cubic inch of perfectly pure water at 62° F., and 30 inches of the barometer, weighs 252.458 grains; by which it will be seen that it is 815 times heavier than atmospheric air. Its specific gravity is 1.0, it being made the

standard by which the densities of other bodies are estimated. The specific gravity of frozen water is 0.92; that of aqueous vapor 0.6202, air being 1.0. Water changes its volume with the temperature; its greatest density is at about 39° F., and its specific gravity decreases from that point either way. By the enormous pressure of 30,000 pounds on the square inch 14 volumes of water are condensed into 13 volumes. Water evaporates at all temperatures, but at 212° F. this takes place so rapidly that it boils, and is converted into vapor (steam), whose bulk is about 1700 times greater than that of water.

Pure water is perfectly transparent, odorless, and colorless, and evaporates without residue or even leaving a stain behind. The purest natural water is obtained by melting snow or frozen rain, that has fallen at some distance from any town. Absolutely pure water can only be obtained by the union of its gaseous constituents; but very pure water, sufficiently so for all chemical and philosophical purposes, may be procured by the careful distillation of common water. The following are the tests usually employed to ascertain the purity of water, or the nature of the substances it holds in solution:

1. *Ebullition.* If a precipitate is formed, or a crust deposited on the vessel, it indicates the presence of carbonate of lime. This is the cause of the calcareous fur that lines tea-kettles and boilers used for common water.

2. *Evaporation.* The matter left behind when water is evaporated is impurity; if it be organic matter smoke and a peculiar odor will be evolved as the residue becomes dry and is charred.

3. *Protosulphate of iron.* If a little of this test be added to water placed in a stoppered vial, and a reddish-brown precipitate forms in a few days, the presence of oxygen gas is indicated.

4. Neither *litmus*, *syrup of violets*, nor *turmeric* is discolored or affected when moistened with pure water; if the first two are reddened, it indicates an acid; if the last is turned brown, an alkali.

5. *Lime-water* mixed with pure water remains transparent; if a milkiness ensues when the test is employed before the water has been boiled, and not after, carbonic acid is present.

6. *Chloride of barium* occasions a white precipitate, insoluble in nitric acid, in water containing sulphuric acid (usually in the state of sulphate of lime).

7. *Oxalate of ammonia* occasions a white precipitate in water containing carbonate or sulphate of lime.

8. *Nitrate of silver* occasions a cloudy white precipitate, insoluble in nitric acid, but soluble in ammonia, in water containing chlorine or muriates.

9. *Phosphate of soda and ammonia* added to water that has been boiled, and precipitated by oxalic acid (if required), produces in a few hours a white precipitate if the water contains magnesia.

10. *Tincture or infusion of galls* turns water containing iron black; when this takes place both before and after the water has been boiled, the metal is present under the form of sulphate; but if it only occurs before boiling, then carbonate of iron may be suspected, and will be precipitated as a reddish powder by exposure and heat.

11. *Ferrocyanide of potassium* gives a blue precipitate in water containing a sesqui-salt of iron, and a white one, turning blue by exposure to air, in water containing a proto-salt of iron.

12. *Sulphuretted hydrogen* and the hydrosulphurets give a brown or black precipitate in water containing iron or lead.

13. *Soap*, or a solution of soap in alcohol, mixes easily and perfectly with pure water, but is curdled and precipitated in water containing carbonates, sulphates, or muriates.

Distilled water, the purest kind of artificial water, is obtained in quantity by the distillation of common water, observing to reject the first and last portions that come over. (See *Still*.) Pure distilled water is unaffected by solutions of the caustic and carbonated alkalies, lime, baryta, oxalic acid, acetate of lead, nitrate of silver, or tincture of soap. *Rain water* is a very pure kind of natural water, but contains minute quantities of air, carbonic and nitric acids, carbonate of ammonia, etc. *Snow water* is the purest of all natural waters. *Spring water* is rain water which has percolated through the earth and usually contains mineral impurities. *River water* is less pure than good spring water. *Well water*, less pure than spring or river, usually contains large quantities of carbonate and sulphate of lime. *Lake water* resembles river water, but contains more organic matter in a state of decomposition. Pure water is incapable of putrefaction, but ordinary

water contains a small quantity of organic matter in solution, which speedily undergoes decomposition, even in closed vessels. This is especially the case with water kept in wooden casks or open cisterns into which leaves and insects may be driven by the wind. Among the simplest methods for purifying water are the following:

1. Filtration or agitation with coarsely powdered fresh-burnt charcoal, either animal or vegetable, but preferably the former. This will not only remove mechanically suspended matter, but also the calcareous and gaseous impurities held in solution.

2. By exposing it freely to the action of the air, by which the organic matter, becoming oxidized and insoluble, speedily subsides. This operation may be easily performed by agitating the water in contact with fresh air, or by forcing fresh air through it by means of a bellows.

3. The addition of a little sulphuric acid to water has a like effect; 15 or 20 drops are usually sufficient for a gallon. This addition may be advantageously made to water intended for filtration through charcoal, by which plan at least two-thirds of the latter may be saved.

4. An ounce of powdered alum (dissolved) well agitated with a hogshead or more of foul water, will precipitate the foul matter in the course of a few hours, when the clear portion may be decanted. When the water is very putrid, a scruple to a drachm may be employed to the gallon, and any alum that may be left in solution may be precipitated by the cautious addition of an equivalent proportion of carbonate of soda.

5. A solution of red sulphate of iron acts in the same way as alum; a few drops are sufficient for a gallon.

6. Agitation with about the half of 1 per cent. of finely powdered black oxide of manganese has a similar effect to the last.

7. The addition of a *little* aqueous chlorine, or chlorine gas, to foul water cleanses it immediately. This method has the advantage of the water being perfectly freed from any excess of the precipitant by heat. The necessity of pure water in photographic operations is almost absolute, and the best distilled water should always be used where it is possible to obtain it; and this need not be an impossibility if every photographer would provide himself with a still, such as is described in this work, and the cost of which is but a few dollars. The water used for washing prints should be passed through a filter. One of the best for this purpose is the "carbon filter." There is nothing superior to it for freeing water from impurities not held in complete solution.

Water Colors. These are the ordinary colors that work well in water, made into a stiff and perfectly smooth paste with gum water, or isinglass size, or a mixture of the two, and then compressed in a polished steel mould, and dried.

Water Development. Some years ago Dr. Backlandt suggested that dry gelatine plates be immersed in

Pyrogallic Acid	10 parts.
Salicylic Acid	1 part.
Gum or Dextrin	10 parts.
Alcohol	4 "
Water	20 "

and allowed to dry at ordinary temperature. Such plates, after exposure, may be developed by plunging the plates in pure water to which a small quantity of liquor ammoniæ is added.

Water-Glass. Syn., Sodium silicate. A syrupy liquid used as a substratum on glass in the collotype process.

Waterhouse Diaphragms. All objectives are now fitted with diaphragms. These were at first inserted in the hood of the lens, and kept in place by a ring. Lake Price suggested a slit in the tube in which loose metal strips pierced with apertures (diaphragms) could be inserted. Dr. Waterhouse further simplified the system, and hence diaphragms which take the form of loose metal strips are called Waterhouse diaphragms.

Water Lenses. Lenses suitable for photographic purposes, made hollow and filled with water or other liquid, are called water lenses. Such lenses were made by Sutton, Archer, and others many years ago. A patent has recently been taken for such a lens in an improved form by M. D. Gunn.

Water-Level (Spirit-Level). An instrument used to arrange the camera (more particularly for architectural pictures) horizontally. It is either oblong or round and filled with water, or better still, with spirits just sufficient to form a bubble, which always goes to the highest point in the instrument. A mark shows where the bubble must be when the camera stands horizontally.

Water of Crystallization. Some crystallized salts contain more or less water, which,

as it bears a definite proportion to the other components of the salt, may be considered as one of its essential constituents. This is termed the water of crystallization, as without it crystals could not be formed. But it does not follow that all salts in crystals contain water, as many are anhydrous.

Waterproof Cement. A kind of emulsion cement well spoken of is the following: Dissolve of gum sandarac and mastic each 5½ drachms in ½ pint of alcohol, and add 5½ drachms of turpentine. Place the solution in a glue-pot over the fire, and gradually stir into it an equal quantity of a strong, hot solution of glue and isinglass; strain while hot through a cloth.

Waterproof Cloth. Cloth made impervious to water. This may be done in either of the following ways: 1. Spread the liquid juice of the caoutchouc tree upon the inner surface of the cloth, and allow it to dry. 2. Imbue the cloth on the wrong side with a solution of isinglass, alum, and soap, by means of a brush. When dry it is brushed on the wrong side against the grain, and then gone over with a brush dipped in water. 3. Apply first a solution of India-rubber in turpentine, and afterward another India-rubber varnish, rendered very drying by the use of driers. On this, wool or other material of which the fabric is made, cut into proper lengths, is spread, and the whole passed through a press, whereby the surface acquires a nap or pile. 4. Moisten the cloth on wrong side with a weak solution of isinglass; when dry, with an infusion of nutgalls.

Waterproof Liquid. For rendering leather or cloth waterproof, this may be made: 1. By dissolving ½ of an ounce of India-rubber in ¾ of a pint of oil of turpentine; put them into a pot, tie it over with a bladder, and set it in hot water; when dissolved, add hot boiled oil, 1 pint. 2. Linseed oil, 1 pint; yellow wax and common turpentine, of each 2 ounces; Burgundy pitch, 1 ounce; melt together. 3. Boiled oil, 1 quart; India-rubber, 1 ounce; dissolve by heat. 4. Linseed oil, 1 pint; suet, 8 ounces; beeswax, 6 ounces; rosin, 1 ounce; melt together.

Waterproof Varnish. (See *Varnish*.)

Water Tests, Simple and Inexpensive. In some sections of the country the water is strongly impregnated by chemicals and foreign matter, which, though perhaps invisible to the eye, nevertheless work mischief to silver nitrate and toning-baths. The following chemical tests will be found useful, if the artist has vainly tried to overcome difficulties that refuse solution.

Lime. Drop two drops of strong oxalic acid solution in the test-tube and flow upon the surface. If milky, lime is present.

Alkalies. Dip a bit of blue litmus-paper in vinegar. Immerse it in the water. If it regains its true shade alkalies are present.

Carbonic Acid. Add an equal part of clear lime-water. If carbonic acid is present, a precipitate is seen; now add muriatic acid and it will effervesce.

For Magnesia. Boil to $\frac{1}{10}$ of its weight, add a few grains of neutral carbonate of ammonia and a few drops of phosphate of soda. The magnesia will now precipitate.

For Iron. Boil nutgalls and add to the water. If iron be present it turns slaty gray. Add a pinch of prussiate of potash; if it blues, iron is there.

Hard Water. Dissolve good soap in alcohol. Drop a few drops in a glass of water. If it is milky the water is hard. If no change takes place it is soft.

Impure water, defiled by sewage, mud, and foreign matter, can be readily made palatable and healthful, at almost no expense, by boiling. Add to each quart of the boiled water 2 drops of perchloride of iron, a 50 per cent. solution; let it stand five hours, and filter over night through the bottom of a common earthen flower-pot.

The writer, during a period of prevalent disease caused by bad water, has thrown down as great a quantity as a tablespoonful of sediment to a quart of boiled water by this means, and obtained it, limpid and pure, for table use.—*C. Ashleigh Snow.*

Water Varnish. Solution of shellac in borax and ammonia. Used to varnish both negatives and films.

Wave-Lengths of Light-Rays. Light is supposed to consist of or be produced by a substance known as ether; again, it is the name given to the sensation produced on our senses by these ether waves. These waves are not equal in length from crest to crest, nor do they travel from their source at equal paces. Some light-waves are much shorter than others, and in passing from a medium of one density into another of different density are diffracted (turned aside) more than the longer rays. The visible rays which are shortest from crest to crest, and are most diffracted by differing mediums, convey to

us the sensations called blue or violet colors. The rays of intermediate wave-length and refrangibility form yellow or green; those of longest wave-length produce red and orange.

Wax. Syn., Beeswax. *Yellow* wax is the cells of the honeycomb of the bee, purified by melting in hot water and allowing the impurities to subside. *White* wax is yellow wax bleached by exposure to light and air. It is used for making paper negatives semi-transparent, and is dissolved in benzole for encaustic paste, etc., for polishing albumen paper prints.

Wax Varnish. (See *Varnish.*)

Waxing. Coating the paper with a film of virgin wax or soaking the paper in wax for the purpose of making it transparent. Proceed with this operation as follows:

1. Take a large silvered plate, as for a daguerrean proof, and place it on a horizontal support, and then heat it over a spirit lamp, or better still, place it over boiling water, and then at the same time with the other hand rub it on top with a piece of virgin wax, which thus becomes melted. When you have a fine coating of melted wax lay your paper where you can facilitate perfect adherence with the aid of a paste-board. When it is very uniformly imbued, remove it and place it between several sheets of very even blotting-paper, over which pass an iron moderately hot in order to carry off the excess of wax. It is very essential that the wax should be removed very uniformly and remain only in the texture of the paper. A sheet well prepared should not present in daylight any shining point at the surface, and should be perfectly transparent. The degree of heat of the iron is sufficient when spittle simmers upon its surface without being detached. At a higher degree of temperature, it would spoil the wax and spot the paper. For this preparation preference must be given to very fine paper.

2. The vessel in which the wax is to be melted must be contrived so as never to allow of its reaching a higher temperature than 212° F., or decomposition of the wax might ensue. The most convenient apparatus is a tin vessel of suitable size, having a tray, about one inch deep, for the wax, fitting into it. The under vessel is to be half filled with water, and by keeping this at the boiling temperature the wax above will soon become liquid. The wax is to be made perfectly liquid, and then the sheets of paper, taken up singly and held by one end, are gradually lowered on the fluid. As soon as the wax is absorbed, they are lifted up with a rather quick movement, held by one corner, and allowed to drain until the wax, ceasing to run off, congeals on the surface. The paper in this stage will contain far more wax than necessary; the excess may be removed by placing the sheets singly between blotting-paper, and ironing them; but this is wasteful, and the loss may be avoided by placing on each side of the waxed sheet two or three sheets of unwaxed photographic paper, and then ironing the whole between blotting-paper. Those that are imperfectly waxed may be made the outer sheets of the succeeding set. Finally, each sheet must be separately ironed between blotting-paper, until the glistening patches of wax are absorbed. The temperature of the iron should not exceed that of boiling water. This is one of the most important points in the whole process.

Waxing Prints. Dr. Eder gives a brilliant surface to prints upon albumenized paper by treating them with:

White Wax	100 parts.
Dammar Varnish	4 "
Rectified Essence of Turpentine	100 "

To preserve the solution it is put into a well-dried bottle, and when it thickens by evaporation a little more rectified turpentine is added.

Waxed Cloth. This can be made in the same manner as directed for waxing paper; or by saturating the cloth with wax dissolved in turpentine, and when dry passing through a warm roller press between sheets of fine bibulous paper.

Waxed Paper. Paper saturated with white wax. (See *Waxing.*)

Waxed-Paper Process. This is a negative process which immediately followed the calotype; it gave place, in general, to collodion, and is not now much practised. The formulæ are numerous, from which we select the following:

1. *Mr. Dawson's Process.* The best paper should be selected. Hold up each sheet separately between the eyes and a strong light; should considerable inequalities of texture, innumerable pin-holes, or black-greenish spots be visible, reject the sheet. A uniform texture perfectly free from impurities is an absolute necessity to successful results. Having selected the number of sheets

required, *wax* the smooth side in the manner described under "*Waxing.*" When the waxed paper is dry, the next step is to *iodize the paper.* This is an important operation. With English paper, iodide of potassium alone is sufficient to produce all the gradations of tone, inasmuch as it has more body, so to speak, than any of the foreign negative papers. Presuming, however, that Cannon's paper has been waxed, rice-water, whey, or gum tragacanth are the best iodizing mediums. *a.* To iodize with *rice-water*, wash 4 ounces fine rice, first in ordinary spring, then distilled water. When the impurities adhering to or mixed with the rice have been thus removed, put it in a glazed earthenware pipkin along with 2 quarts distilled water; place on a clear fire; the moment ebullition begins, remove and stir with a glass rod for a few minutes; pour off the liquid portion into a bottle or glass beaker, where it should stand for two days, covered over from dust, to allow the sediment of rough particles of starch to settle to the bottom. At the end of this time decant off rather more than a quart of the clear liquid, which filter through three or four folds of fine muslin, and add iodide of potassium, 400 grains; bromide of potassium, 80 grains; cyanide of potassium, 30 grains; fluoride of potassium, 15 grains; chloride of sodium, 8 grains; sugar of milk, 2 ounces, avoirdupois; gum-arabic, 1½ ounces. At first the solution is of a dirty-milkish color; but after two or three weeks' standing it will become beautifully clear, and when used once or twice, of a pale sherry color. It should not be used until it becomes clear. *b.* If *whey* is used, take calf's stomach, quite fresh from the slaughter-house; wash thoroughly; cut it up into small pieces, and preserve in a bottle of alcohol. When wanted, pick out three or four pieces and put them into about three quarts of good skimmed milk, slightly warmed; stir with a glass rod, and place the vessel in a warm place. After a short time, whey will separate from the caseine. When this is completed, press out the liquid, boil it in an earthenware pipkin and skim it; strain through three or four folds of fine muslin, and allow it to stand for a few days. To 1 quart of the clear part add iodide of potassium, 500 grains; bromide of potassium, 100 grains; cyanide of potassium, 30 grains; fluoride of potassium, 15 grains; chloride of potassium or sodium, 8 grains. When this solution has stood for two or three weeks it becomes perfectly clear, and is fit for use. *c.* When *gum tragacanth* is to be used, first dissolve 30 grains of the gum in about a pint of distilled water, then add distilled water, 1 pint; iodide of potassium, 500 grains; bromide of potassium, 125 grains; gum-arabic, 1½ ounces, avoirdupois; free iodine, 2 grains. The color of this solution should be about the same as sherry, and when it becomes clear by use, add more free iodine. Either of these formulæ will give excellent results. When the iodizing solution is wanted, pour into a porcelain tray a sufficient quantity to cover completely ten or twelve papers. Immerse them one by one, removing the air-bubbles carefully with a brush kept for the purpose. To avoid any unevenness in iodizing move them about occasionally with the brush during the soaking. After working for at least three hours, hang up to dry. Many of the papers, especially if the solution is a crude one, may assume a dirty marbled appearance, but this does not in the least spoil them, and will entirely disappear in the exciting solution. These papers will keep three or four months. The paper is sensitized in a 40-grain nitrate solution rendered slightly acid by acetic acid, and is then washed with water to reduce the amount of free nitrate of silver. After exposure in the camera the picture is developed in the usual way, care being taken to keep the developveloping dish perfectly clean.

2. *M. De la Blancher's Process.* After the sheet has been properly waxed it is ready for iodizing. The following special conditions are to be observed in the preparation of the iodizing solution: It should contain a size strong enough to fill up the pores of the paper and make it more approaching the condition of a smooth inert surface. If too thick, the size produces oblong drops or irregular lines on the sheet when hung up to dry, which are liable to form black stains in the gallic acid developing solution. The iodide should not be in too large quantity, otherwise, after having penetrated the pores of the paper, there is formed in the exciting medium too dense a film of iodide of silver, which produces thick and opaque pictures. The sizing is produced in the following manner: Take water, 1 quart; best rice-water, 5 ounces; linseed, 1½ ounces; fine gelatine, ¾ ounce. The latter should be dissolved by aid of heat; the rice and linseed should be allowed to digest a little,

without bursting the grains of rice. Mix as recommended for 1; then take of the size solution, 1¾ pints; sugar of milk, 1¼ ounces; iodide of potassium, 9 drachms; bromide of potassium, 80 grains. The sheets are to be immersed, one after another, for ten minutes at most, carefully avoiding air-bubbles, and then hung up to dry. This paper will remain good for two or three months, and after that time it can be restored by re-immersing in the iodizing bath. The remaining operations of exciting, etc., are performed in the ordinary manner.

3. *M. Tillard's Process.* Melt 1550 grains white wax in 70 ounces of oil of turpentine over a hot-water bath; allow it to stand twelve hours, then filter. Add to the filtrate 2 per cent. of iodide, when combination will take place with effervescence. Add to this 10 per cent. of cold prepared castor oil. The paper passed through this bath becomes transparent, acquires the firmness of parchment, and does not stain by long immersion in the gallic acid. After removal from this bath and it becomes perfectly dry immerse it in a bath composed of water or milk of serum, 40 ounces; iodide of potassium, 372 grains; bromide of potassium, 93 grains; albumen, 11 ounces. The sheets may be placed one upon the other, avoiding air-bubbles. Fifteen minutes' immersion is sufficient, but they may remain longer. Hang up to dry. A piece of blotting-paper must be attached to each sheet, to facilitate drying. Make the sensitive bath of nitrate of silver, 310 grains; nitrate of zinc, 155 grains; citric or acetic acid, 3 drachms; filtered rain or distilled water, 18 ounces. It should be prepared two or three days beforehand. Immerse the paper for about four minutes, then wash in two waters. *To develop*, take of a saturated solution of gallic acid, 14 drachms; distilled water, 14 drachms; nitrate bath solution, 5 or 6 drops, and be careful not to add too much, as it produces coarseness. Wash and finish in the usual way.

4. *Rev. Mr. Law's Process.* Wax the paper, which should be selected as before directed, by the method as given in article *Waxing*. *To iodize the paper:* To 20 grains of distilled water add 225 grains of iodide of potassium, 112½ grains of bromide of potassium, a large tablespoonful of pure honey and as much free iodine as will give the liquid a deep cherry tint. Having filtered this, pour sufficient into a flat dish and proceed to immerse the papers in the following manner. Take a sheet by the opposite corners and lower it in the liquid quickly, carefully avoiding air-bubbles, and with a bent-glass rod press the sheet under, passing from one end of the sheet to the other. Proceed in the same manner until the dish is nearly full; allow them to soak for some time and hang up to dry. The papers, when dry, should present an even, uniform brown or purple color. *To sensitize:* The strength of the nitrate bath should be 30 grains to the ounce of distilled water, and 31 minims of glacial acetic acid. The strength should be kept up to this, and after having excited about half a dozen sheets, add about 35 grains of nitrate of silver and 35 minims of glacial acetic acid to each 8 ounces of solution. Immerse the paper in this bath in the same manner as for iodizing, only excite one sheet at a time, and allow it to remain until all the brown color has disappeared, when it may be transferred to a dish of water, and subsequently to a second, if the paper is to be kept for some time. Blot off all the moisture before hanging up to dry, otherwise stains are apt to make their appearance. *Expose* as soon after sensitizing as possible, if quickness is desirable. *For developing*, prepare a saturated solution of gallic acid in distilled water, and add a drachm of freshly prepared aceto-nitrate with twice the quantity of glacial acetic acid, used for exciting solution, to each 6 ounces of the gallic acid solution, *i. e.*, 1 ounce of water, 30 grains of nitrate of silver, and 70 minims of glacial acetic acid. Take care to develop sufficiently, so as to get the black deposits on the high lights, or the durability of the finished negative will be problematical, and it will be impossible to print from it by development. Wash and fix in the usual way.

5. Wax the paper as usual and *iodize*, with water, 10 ounces; iodide of potassium, 100 grains; bromide of potassium, 30 grains; pure urea, 30 grains; free iodine, sufficient to produce a sherry color. *Excite* with a 30-grain bath containing 1 drachm of glacial acetic acid to the ounce. Development and other practical details the same as for other waxed-paper processes. Over-developed negatives may be lightened by first soaking them in common water for some time, until they become impregnated; then plunge them into a solution of 5 parts of iodide of

potassium in 100 parts of water. It sometimes requires twenty-four hours to produce the desired effect.

6. *M. De Carawza's Process.* The paper which most photographers reject is that particularly selected by M. De Carawza, he preferring sheets very much pressed and full of small holes. His method of waxing is more tedious than any of those given under *Waxing*, and possesses no advantage. *To iodize the paper:* In 35 ounces of distilled water put 48 grains of starch and boil it until it is perfectly dissolved. Having taken it off the fire, add sugar of milk, 620 grains; iodide of potassium, 232 grains; cyanide of potassium, 121 grains. Whilst still tepid, strain it and pour it into a dish and introduce one by one a dozen sheets of waxed paper, taking care to let the liquid run all over them, and with a badger's brush remove the bubbles of air which will otherwise adhere to the paper. Let it remain for half an hour, agitating the dish frequently; after this the sheets should be taken out one by one and hung up to dry. Care must be taken not to put the wax into the solution without first making it tepid. The dry sheets ought to be very white and of a very granulated appearance. *Sensitizing the paper:* The following solution is to be prepared in a blue or black bottle; distilled water, 17½ ounces; nitrate of silver, 542 grains; crystallizable acetic acid, 620 grains. This may be used in an hour after it is made. Filter the solution into a dish and plunge a sheet into it, taking care to agitate the dish continually. After four minutes of immersion the sheet becomes of a milky color, and resembles opal glass. It should then be taken out and immersed in a dish of rain or distilled water, agitated strongly, and placed in another dish of distilled water in the same manner, then passed between sheets of blotting-paper, and placed upon the plate of the frame; the plate is then put into the frame, the edges of the paper being folded back so as to stretch it as much as possible. In a few seconds the paper becomes very much stretched and the surface very even. This method insures a high degree of finish and prevents the paper contracting by the heat. The nitrate solution having been returned to the bottle, it is necessary to add 150 grains of animal charcoal; shake the bottle well and allow it to rest until it is required again. *Develop* with a solution of gallic acid, prepared immediately before using. Filter it and add a few drops of fresh nitrate. As soon as the picture appears, wash it and then plunge it into a solution of hyposulphite of soda, 1550 grains; rain water, 21 ounces. Half an hour's immersion is sufficient. The picture is then taken out and left for twelve hours in hot water, which should be frequently changed.

7. *M. Duchochois' Process.*—Wax the paper as usual. *Iodize* with serum of milk (*cold*), 47 fluidounces; iodide of potassium, 1½ ounces; bromide of potassium, ½ ounce. To which may be added, if desirable, the albumen of ten eggs. Immerse the waxed paper in the cold iodizing solution for ten or fifteen minutes, and hang up to dry. *Sensitize* in distilled water, 3½ ounces; crystallizable acetic acid, ½ ounce; neutral nitrate of silver 130 grains, neutral nitrate of of zinc, 60 grains. The silver and zinc ought to be dissolved in the water before adding the acetic acid. Immediately after sensitizing wash very carefully, first in distilled water, and afterward in a second water. Drain between blotting-paper, and let it dry between other clean sheets, when it must be kept until wanted for use. *Develop* in distilled water, 3½ ounces; gallic acid, 15 grains; acetic acid, 1 drachm. When this has remained about ten minutes in the developer, add 1 drachm of the nitrate bath, and if too long in developing add more, but slow development produces the best prints. Wash for three-quarters of an hour, and then fix in hyposulphite of soda, 180 grains; water, 3 ounces; acetic acid, 4 drops.

Weight. *Weight* is the measure of the force by which any body, or any given portion of a substance, gravitates toward the earth. The estimation of the weight of bodies is called *weighing*, and consists in the comparison of the thing weighed with some conventional standard. This standard may be determined by the constant ratio which exists between the volume and the weight or gravitating power of the same substance when placed precisely in the same physical condition; hence for the *primary* creation of a standard weight, reference must be had to the measure of the volume of some substance, as a cubic foot or inch of pure water or mercury, the weight of which is constant at the same temperature and under the same atmospheric pressure. The

method of estimating the weight of bodies, without reference to their volume, or to a standard which is already known, is difficult and uncertain. In fact, it is impossible to communicate merely by oral description, without reference to some sensible object, a proper idea of a pound weight or a foot rule, since the mind requires some known measures of volume or gravitating power for the purpose of comparison. The original standard of small weight was the grain, or corn, of wheat; and of measure, the foot, cubit, span, pace, etc., derived from the human body; but since the size of grains of wheat and the linear surface of the human body varies under different circumstances and in different individuals, however carefully the specimens may be selected with a view to an average, it is very evident that such bodies can never furnish permanent and accurate standards of comparison. But the elements of such a standard of measure are furnished by aid of natural philosophy and a refined knowledge of the arts. The form and magnitude of the earth are presumed to remain the same in all ages, and hence a determined proportion of its circumference, as $\frac{1}{360}$th, or a degree, will represent an unalterable standard fit for the purposes of metrology. The force of gravitation at the earth's surface is also constant under the same parallels of latitude and at the same elevation above the level of the sea, and hence the length of a seconds pendulum is invariable at any given place, under precisely similar circumstances. This furnishes a second element for the determination of a lineal standard, which by its involution forms similar standards of measure, both of superfices and volume. A measure of bulk or volume being determined, it is easy to estimate weight, or the gravitating power of any substance, by reference to such a standard. As soon as a unit of weight or measure has been agreed on, and a model weight or measure formed, the latter becomes the standard, and others may of course be readily formed by mere comparison; but when these standards, or their representatives, are lost, recourse must be again had to science and calculation. The relation between the weight and volume of a body, compared to a given standard taken as unity, constitutes its specific gravity. For the purpose of *weighing*, a balance or lever is required, which, when accurately suspended in a state of equilibrium will be like affected by like weights applied to either extremity. A balance with *unequal arms* will weigh as accurately as another, of the same workmanship, with *equal arms*, provided the substance weighed be removed and standard weights be placed on the same scale till the equilibrium be again restored, when the weights so employed, being exactly in the same condition as the substance previously occupying the scale, will of course indicate its proper weight. A knowledge of this fact is useful, as it enables anyone to weigh correctly with unequal scales, or with any suspended lever. *Small weights* may be made of thin leaf-brass. Jeweller's foil is a good material for weights below one-tenth of a grain, as low as the one-hundredth of a grain; and all lower quantities may be either estimated by the position of the index, or shown by actually counting rings of wire the value of which has been determined, The readiest way to subdivide small weights consists in weighing a certain quantity of small wire, and afterward cutting it into such parts, by measure, as are desired. The wire ought to be so thin that one of the rings may barely produce a sensible effect on the beam.

The tables below represent the values and relative proportions of the principal weights employed in commerce and the arts.

Weights and Measures. The formulæ given in photographic literature are expressed in French (metric), English or American terms of weight and measure, or more simply in parts and volumes. The complications arising from the use of so many different systems are often the source of many difficulties in photographic practice, which, however, can be easily overcome by the adoption of one system—preferably the metric system, as the one most widely used by scientific workers—and the conversion of formulæ differently expressed into the terms of that system. To adopt this system the photographer needs only gramme weights and cubic centimetre graduates for formulæ written in metrical form, and conversion tables for English weights, as given below.

U. S. Weights and Measures.

Volume—Liquid.

4 gills	1 pint.
2 pints	1 quart.
4 quarts	1 gallon.

Fluid.

Gallon.		Pints.		Ounces.		Drachms.		Minims.
1	=	8	=	128	=	1024	=	61,440
		1	=	16	=	128	=	7,680
				1	=	8	=	480
						1	=	60

A fluidpint is sometimes called a fluid-pound.

Troy Weight.

Pound.		Ounces.		Pennyweights.		Grains.
1	=	12	=	240	=	5760
		1	=	20	=	480
				1	=	24

Apothecaries' Weight.

℔		℥		ʒ		℈		gr.
Pound.		Ounces.		Drachms.		Scruples.		Grains.
1	=	12	=	96	=	288	=	5760
		1	=	8	=	24	=	480
				1	=	3	=	60
						1	=	20

Avoirdupois Weight.

Pound.		Ounces.		Drachms.		Grains (Troy).
1	=	16	=	256	=	7000
		1	=	16	=	437.5
				1	=	27.34

English Weights and Measures.

Apothecaries' Weight.

20 grains	=	1 scruple
3 scruples	=	1 drachm
8 drachms	=	1 ounce
12 ounces	=	1 pound

Fluid Measure.

60 minims	=	1 fluiddrachm
8 drachms	=	1 fluidounce
20 ounces	=	1 pint
8 pints	=	1 gallon

The above weights are generally used in formulæ. Chemicals are usually sold by

Avoirdupois Weight.

27.34 grains	=	1 drachm
16 drachms	=	1 ounce
16 ounces	=	1 pound

Tables for the Conversion of "English" Measures and Weights into "Metric" and Contrariwise.

Conversion of Grains and Ounces into Grammes.

	Grains to Grammes.	Ounces to Grammes.	Grains to the Ounce = Grammes to 100 c.c.
1	0.06479	28.3495	0.22817
2	0.12958	56.6990	0.45635
3	0.19437	85.0485	0.68452
4	0.25916	113.3980	0.91269
5	0.32395	141.7475	1.14086
6	0.38874	170.0970	1.36904
7	0.45353	198.4465	1.59721
8	0.51832	226.7960	1.82538
9	0.58311	255.1455	2.05356

Conversion of Minims, Drachms, Ounces, and Pints to Cubic Centimetres and Litres.

	Minims to c.c.	Drachms to c.c.	Ounces to c.c.	Pints to Litres.
1	0.05916	3.5495	28.396	0.56792
2	0.11832	7.0990	56.792	1.13584
3	0.17748	10.6485	85.188	1.70376
4	0.23664	14.1980	113.584	2.27168
5	0.29580	17.7475	141.980	2.83960
6	0.35496	21.2970	170.376	3.40752
7	0.41412	24.8465	198.772	3.97544
8	0.47328	28.3960	227.168	4.54336
9	0.53244	31.9455	255.564	5.11128

Relation of Metric to Avoirdupois Ounces and Grains.

Metric Weights.	Equivalents in ounces and grains.		Metric Weights.	Equivalents in ounces and grains.	
Grammes.	Oz.	Grains.	Grammes.	Oz.	Grains.
1	0	15½	10	0	154
2	0	31	15	0	231
3	0	46	20	0	308
4	0	62	28.35	1	
5	0	77	30	1	25
6	0	92	35	1	103
7	0	108	50	1	334
8	0	123	500	17	279
9	0	139	1000	35	120

Relation of Metric to United States Fluid Measure.

Cubic centimetres	Fl.oz.	Fl.dr.	Minims.	Cubic centimetres	Fl.oz.	Fl.dr.	Minims.
1	...	...	16	55	2	6	52
5	...	1	21	60	2	0	14
10	...	2	42	65	2	1	36
15	...	4	3	70	2	2	56
20	...	5	25	75	2	4	18
25	...	6	46	80	2	5	38
30	1	0	7	85	2	7	0
35	1	1	28	90	3	0	20
40	1	2	49	95	3	1	42
45	1	4	10	100	3	3	3
50	1	5	31				

1000 c.c. = 1 litre = 34 fluidounces nearly, or 2⅛ pints

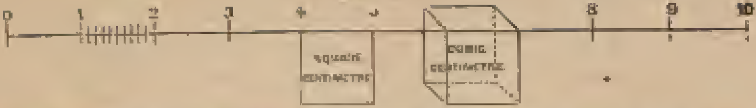
Relation of Metric to United States Measures of Length.

1 millimetre = $^1/_{25}$ of an inch.
1 centimetre = $^2/_5$ of an inch.
1 metre = 39⅜ inches.
1 kilometre = ⅝ of a mile.

To Convert the Centigrade or Celsi Scale into the Fahrenheit Scale.

If above the freezing-point of water, multiply the degrees by 9, divide by 5, and add 32°.

Fig. 245.



Weights, Measures, and Formulæ. A committee appointed by the Photographic Convention has fully discussed the relative merits of the English and French system of weights and measures, and their report, which was adopted by the Convention, contains the following recommendations:

(A.) Weights and Measures. 1. If the metric system be used, weights will naturally be expressed in grammes, and measures in cubic centimetres.

2. If the English units be used, the minim and the drachm should not be employed at all. All weights should be expressed in ounces and fractions of an ounce; all measures in fluidgrains, or in fluidounces and fractions of a fluidounce.

(B.) Formulæ. 3. Formulæ should give the number of parts of the constituents, by weight or measure, to be contained in some definite number or *parts, by measure*, of the solution. The mixture can then be made up with (1) grammes and cubic centimetres, or (2) grains and fluidgrains, or (3) ounces and fluidounces, according to the unit selected.

4. The standard temperature for making up solutions should be 15° C. or 62° Fahr. No appreciable error will be introduced by the fact that these two temperatures are not quite identical.

5. Formulæ should give the quantities of the constituents to be contained in x parts of the finished solution, and not the quantities to be dissolved in x parts of the solvent. When a solid dissolves in the liquid, or when two liquids are mixed, the volume of the solution or mixture is, as a rule, not equal to the sum of the volumes of its constituents. The expansion or contraction varies with the nature of the solids and liquids and the proportions in which they are brought together. In making up a solution, therefore, the constituents should first be dissolved in a quantity of the solvent smaller than the required volume of the finished mixture, and after solution is complete the liquid, cooled of necessity to the ordinary temperature, is made up to the specified volume by the addition of a further quantity of the solvent.

6. It is very important to specify in the case of liquids whether parts by weight or parts by measure are intended. The equivalence between weight and measure only holds good in the case of water and liquids of the same specific gravity; a fluidounce of ammonia solution or of ether weighs less than an ounce; a fluidounce of strong sulphuric acid weighs nearly two ounces.

7. Whenever possible, formulæ should give the quantities of the constituents required to make up 10, 100, or 1000 parts of the solution.

8. When a mixture (*e. g.*, a developer) is to be prepared just before use for two or more separate solutions, it is desirable that the proportions in which the separate solutions have to be mixed should be as simple as possible, *e. g.*, 1 to 1, 1 to 2, 1 to 3, 1 to 10.

9. When metric units are employed, the original French spelling "gramme" should be used in preference to the contracted spelling "gram," in order to avoid misreading and misprinting as "grain."

Welford's Bicarbonate Bath. (See *Toning*.)

Wet-Paper Process. (See *Tanner's Wet-Paper Process*.)

Whatman's Paper, Prints on. Soak the paper for two or three minutes in a solution of chloride of ammonium, 75 grains to the quart of distilled water. When dry, brush over it the following solution: Dissolve 1½ ounces nitrate of silver in 16 ounces of water, and set one-third of the solution aside. Precipitate the other two-thirds with ammonia, and add just enough of the precipitant to dissolve the precipitate—not more. Finally, add the one-third of solution set aside, when it will turn turbid. Clear up with a few drops of acetic acid and filter. Print deeply and tone and fix in a combined bath. Make a stock solution of 2 ounces of hypo in 12 ounces of water, to which is added carefully, in small portions and by constant agitation, 15 grains of pure trichloride of gold in 2 ounces of water. Of this stock solution take 3 ounces and add to 15 ounces of a 10 per cent. hypo solution. With this bath the tones of Whatman's, or any other matt-sur-

face paper are entirely at the will of the operator. According to the time left therein you can have tones of all shades, from red to positive black. The prints must not be washed previous to fixing and toning.

Whey. The liquid portion of milk after the curd has been separated. It consists chiefly of sugar of milk.

White Clay. (See *Kaolin.*)

White Ink. Mix 1 ounce of barium sulphate (precipitated), or zinc white, with thin gum-arabic solution, so that it will flow from a pen easily and yet dry white. Used for writing titles on lantern-slide masks and prints.

White Light. (See *Light.*)

White Positives on Glass. This is a modification of the whitening process given elsewhere. Take a picture in the usual way, lay it in a dish containing hot water, and let it remain there about three minutes, then take it out and wash with cold water, drain it a short time, and place it on a levelling-stand; now pour on the re-developing solution, composed of distilled water, 1 ounce; saturated solution bichloride of mercury in muriatic acid, 12 minims; protosulphate of iron, 20 grains; nitrate of potash, 12 grains; alcohol, ½ drachm. On the first application of the solution the picture will almost disappear, and then gradually become more and more developed. Let it remain in this position until you have gained the desired effect, which will take from twenty to thirty minutes; then wash thoroughly with water, and dry by the fire.

White Specks. These are troublesome visitors to the melainotype picture, and sometimes to the positive paper print. They may be avoided in the melainotype by adding 10 or 20 grains of bicarbonate of soda, in solution, to the nitrate bath. If this does not entirely prevent it, add a little more, avoiding milkiness in the bath, and if this does happen, filter and add 2 or 3 drops of acid. The plate should never be cleansed with anything except pure alcohol. (See also *Imperfections in Negatives and Positives.*)

White Spots. These are similar in appearance to the "white specks" on the melainotype, differing, however, in their nature; the specks on the melainotype being due to the acid state of the nitrate bath in connection with organic matter, whilst those in paper positives are due to two causes: imperfections in the sizing, and black spots in the negative. The first difficulty can generally be overcome, when it is inconvenient to select the paper, by *brushing* the sensitive solution over the paper copiously, and working it into the sizing well; papers that are floated are more apt to yield the "white spots" than those that are brushed. White spots produced by black spots in negatives can be touched out with a brush where they are not so numerous as to make this too costly.

White Varnish. (See *Varnish.*)

Whitened Camera. An old-time French invention possessing some advantages, and once it was considered by some an important improvement. By pasting white paper upon the interior walls of the camera-obscura, or what is preferable, by covering them with a coat of white paint, we increase the impressibility of papers and glass in the proportion of nine to fifteen, that is to say nearly one-half. Independently of acceleration in the operation, the image presents more harmony in its *ensemble*. The passage of the shades to the lights is less dry and better graduated. This result is much more valuable from the fact that the proofs are generally injured by exaggerated contrasts, especially when we operate upon glass. A still more valuable result is, that the green, yellow, and red colors which produce so little action upon the sensitive coating when we operate with the camera-obscura, are much better revealed when we have recourse to the white camera. Finally, the use of the whitened camera admits of the formation of the image with a light, which is never permitted with the black camera-obscura, whatever may be the duration of exposition.

Whitening Solution. A solution for whitening ambrotypes. Take bichloride of mercury, 30 grains; water, 1 ounce. By a gentle application of heat the bichloride entirely dissolves. Before applying the solution the image is to be fixed and the plate well washed; it is then to be poured on and suffered to lie until the degree of whiteness required is attained, then poured off and the plate again well washed.

Whiting. Chalk carefully cleared of all stony matter, ground, levigated, and made up into small oblong cakes. As it is often used as a polishing material for glass plates, etc., it should be very carefully freed from all particles of flint or sand.

Whole Plate. A size for plates and photographs (Germany and France, 18 x 24 cm.; England, 6½ x 8½ inches).

Wide-Angle Lens. "Covering-power" in a lens depends upon its focal length. Lenses made to cover plates large in proportion to their focal length are called wide-angle lenses. Such lenses are necessarily short in focal length, and include from 70° to 115° of a view—foreshortening the perspective.

Wide-Angle Rectilinear. An objective, constructed by Dallmeyer, comprising a very large angle of field. It is free from spherical and chromatic aberration.

Willesden Paper. A commercial waterproof cardboard or paper, used for making baths, etc. The paper is made waterproof by immersion in a solution of cupric oxide in ammonia.

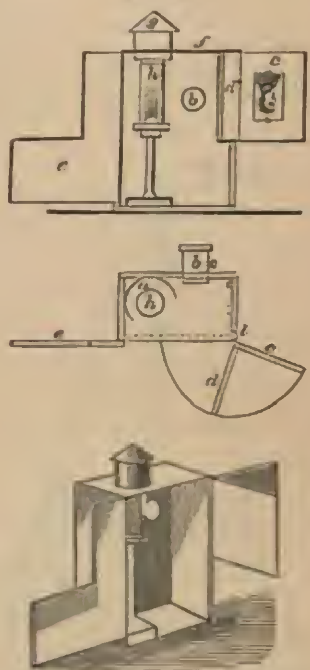
Wine, Spirits of. A name given in Europe to *alcohol* (which see).

Wing's Multiplying Camera. This instrument has four sets of lenses (portrait combinations), and carries a plate 12 x 15 inches. This plate is placed in a movable shield which has both a lateral and a vertical movement, and by certain parts of adjustment can be set to take on the one plate from 4 to 16 negatives, the largest picture 4¼ x 5½ inches, and the smallest ¾ inch square.

Wire, Magnesium. One of the commercial forms of magnesium, used in flash-light photography.

Wonder Camera. The so-called "wonder camera" is intended to show opaque objects upon a screen, much enlarged and in their original colors. A common card photograph may be shown as large as life without the least coarseness, but as fine as the original. Colored lithographs of all kinds are very beautiful when enlarged in this manner. As a means of amusement it rivals the magic-lantern. It consists of a wooden box with a top made of tin or sheet-iron; the chimney is made of the same material. The lens is the same as used upon a camera for making photographs. At the back of the box (as will be seen by reference to the plan and elevation) are two doors placed upon hinges. When the box is in use the door, *e*, is kept closed. The other door consists of two parts placed at right angles to each other; the object of this is to fill the opening in the door, *e*, while the pictures are being attached to *c*; when *c* is swung into position opposite the lens placed at *b*, *d* is carried to one side. If stereoscopic views are to be shown, a slit may be cut at *e*, through which they may be inserted without opening the box. The door, *e*, should be cut off a little at the bottom so as to admit the air. The light is placed at *h*, as nearly opposite the picture as possible. It should be a strong light; an Argand burner is the best. At the back of the light is a piece of tin bent in the form of a reflector. The light coming from *h*

Fig. 246.



strikes *c*, and is reflected through the lens upon the screen. The plan of the box is represented with the top removed. The dimensions depend upon the focal distance of the lens and height of the light. Care must be used to have the distance from the lens to *c*, when closed, equal to the focal distance.

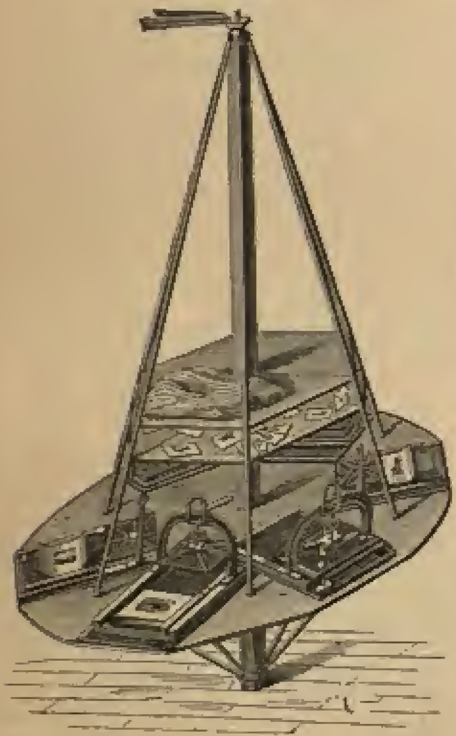
Woodburytype Printing Process. A method invented by W. B. Woodbury, by which a bichromate of gelatine film is exposed under a negative and developed in hot water.

The resulting very delicate gelatine relief

picture, which becomes as hard as stone in the light, is impressed upon a plate of lead (intaglio) by hydraulic power. This intaglio, after being placed horizontally in a hand-press, is flowed with a hot gelatinous color. A piece of paper is now placed over this, the press closed (any surplus color runs off at the sides) and after cooling, the gelatine film firmly adhering to the paper is pulled off and dried. The prints produced by this process bear comparison with silver prints, which they usually surpass in brilliance of half-tones and shadows.

Woodbury's Printing-Table. This table is used in the beautiful process of W. B.

Fig. 247.



Woodbury. The table as contrived revolves. Upon it are placed several heavy iron presses with tops to raise and lower. A printing-matrix, or plate, is placed upon one of the press beds, and the emulsion of gelatine and pigment poured upon its centre. Upon this the ordinary paper is laid. The pressure brought upon the whole drives the emulsion to the extremes of the paper, and the two adhere, making the print, which must be tanned in alum solution.

Wood Blocks, Photographs on. To obtain pictures on wood blocks suitable for wood engraving the collodion process should be used.

The collodion used is a good positive collodion, such as makes good work in tintype, and the same may be said of the silver bath and developer, the picture being made on either glass or on the ferrotype plate, in exactly the same way as if an ordinary tintype is being made, the operation all through being the same till the picture is dry; then a piece of black paper, such as is used for covering cardboard boxes, is smeared over with thick gum mucilage, then put on the pictures and squeegeed into contact, and in a few seconds the paper is stripped off the plate with the collodion image adhering thereto. The wood block is prepared by rubbing over it some gas-black mixed with white of egg, rubbing it well into the block, and leaving only a thin, even film of black on the surface of the block; now cover the block with alcohol, and set this on fire, allowing it to burn right out—this coagulates the albumen and fixes the black; a piece of very fine emery cloth will soon remove any roughness left in rubbing on the black.

The block is now covered with white of egg laid on with a brush, or with the finger; the picture on the black paper is trimmed down to the proper size, then put face down on the block, and squeegeed into contact, using an India-rubber roller squeegee for the purpose; when this is done moisten the back of the paper, and when the gum is loosened, strip off the paper, leaving the collodion film on the block; rub with a wet soft sponge, cover with alcohol, fire it, and the block is ready for the engraver.

Wood Naphtha. (See *Methylic Alcohol.*)

Wood, Photography on. (See *Wood Blocks* and *Photo-Xylography.*)

Wood Vice. A small instrument for holding plates while buffing or cleaning.

Wooden Baths. These baths are made of well-seasoned pine plank, with strips on the sides and bottom, 1¼ inch square, closely set with tongue and groove, and all strongly held by screws two inches apart. The inside is

thoroughly and evenly coated with the best shellac varnish.

Wood's Catalysotype. (See *Catalysotype.*)

Wood's Collodion. Take of sulphate of iron, 40 grains; iodide of potassium, 24 grains; chloride of sodium, 6 grains; alcohol, 20 grains; strong water of ammonia, 3 drops. Mix the powdered salts together and add them to the alcohol, then the water of ammonia. A few pieces of iron wire must be kept in the mixture to prevent the iron from becoming peroxidized. One part of this mixture is to be added to three parts of collodion holding in solution an *alcoholic* solution of common salt in the proportion of 1 fluiddrachm of salt to 4 ounces of collodion. Or, neglecting the salt solution, 5 drops of *chloroform* may be added to 1 drachm of the solution of iodide of iron, and 3 drachms of *plain* collodion. The mixture of collodion and iodide of iron ought to be used shortly after having been made, as the iron becomes peroxidized and spoiled by long contact with collodion. The nitrate solution for exciting the plate should be of the strength of 30 grains to the ounce of water. A little water of ammonia added to the hyposulphite of soda solution brings out the picture more fully when a very short exposure is given. (*Obsolete.*)

Wood's Gilding Dissolvent. A compound invented by Dr. Wood, to remove the coating of gold from the daguerrotype plate, enabling the operator to use his plates two or more times after gilding.

Worden's Method of Taking Unreversed Positives. Glass of uniform thickness must be used—a point easily attended to. Supposing a lot a sixteenth thick to be selected, plane a rabbet a sixteenth deep round the edge of the plate-frame, so that it will lie just so much nearer to the slide. Lay the plate in, *collodion side up*, and on it place another thin plate, to which small triangular pieces of glass have been neatly cemented at the four corners. Close the box and expose in the usual manner. A rather longer exposure will be required than by the ordinary method, about 16 seconds to 12.

Blotting-paper should be laid on the projecting corners of the upper glass plate. The altered plate-frame can only be used for non-reversed pictures.

Worral's Transparencies. In printing upon collodion, take the wet plate out of the bath immediately, lay it upon a blackened surface, and cover the surface with prepared film of gutta-percha, or transparent paper, taking care that no air-bubbles are entangled between the two films; the negative is then placed directly upon the whole, an impression taken, and after the removal of the negative and gutta-percha film, the picture is developed with the ordinary iron positive developer.

To obtain the gutta-percha film, a solution of the gum in benzole may be poured upon a clean glass plate, and when dry removed by immersion in water; or a film of collodion may be previously deposited upon the glass plate, and after the coating is dry, varnished with turpentine mastic varnish; or the mastic varnish may be mixed in the proportion $\frac{1}{4}$ to $\frac{1}{3}$ of the gutta-percha solution. The addition of the mastic varnish renders the film firmer, less liable to curl up by the warmth of the hand, and more transparent.

The prepared gutta-percha film is liable to become spotted, by being in contact with the silver solution, but the spots may be removed by washing with cyanide of potassium. When the film has been once used and is required again before it has become dry, the nitrate solution will be found to have gathered concentrated drops, and if a print is taken without a previous washing of the film in water, dark spots will mar the appearance of the impression; in this case it is requisite to be careful, when laying the film upon the collodion surface, to raise and depress it several times, so as to allow the concentrated drops on the film to become equally diffusde with the solution on the collodion surface.

You may use the iron developer of various strengths, from the most dilute to the most concentrated, with and without acids and alcohol; also pyrogallic and formic acids. When the deposit has been thrown down rapidly, and there is but little intensity in the picture, strengthen with bichloride of mercury, not allowing the solution to remain sufficiently long to whiten the whole image.

The general mode of procedure is only indicated above, as the modifications are infinite, but the results are in many cases superior to any in the ordinary paper printing processes.

Transfer the impressions obtained to white paper by means of a solution of bleached shellac in borax, but in this case the pyrogallic acid must not be used as a negative developer.

Wool, Cotton-. Cotton-wool which has been boiled with sodium carbonate is one of the purest forms of cellulose; used in the preparation of pyroxylin.

Wothlytype. A process devised by Wothly, in 1864, in which paper was coated with a collodion containing nitrate of uranium and silver in concentration. This process is not now in use.

X.

Xanthic Acid. A peculiar acid, composed of sulphur, carbon, hydrogen, and oxygen.

Xantho-Collodion. Take of ether and alcohol (98 per cent.), of each, ½ ounce. Dissolve first in it, 10 grains of iodide of ammonium, and 5 grains of bromide of cadmium. Then dissolve in it 5 grains of pyroxylin, made at the maximum temperature. Then add 1 ounce of the following tincture: To 4 ounces of alcohol (98 per cent.) add 1 ounce of powdered turmeric (curcuma). This tincture should be prepared and frequently shaken several days before being used. The collodion is now of a rich yellow color, and as soon as it settles is fit for use for either negative or positive pictures, or for dry plates. If positives are taken with it either on the black glass or the melainotype plate, the positive presents a very rich tone not unlike the gilded daguerrotype; but this effect is not so pleasing if the positive is taken on white glass and backed with black varnish. The negative, although the collodion has just been made, is very intense and will give a proof the details of which will be exceedingly beautiful. All of these details will print without the least solarization. In the production of the dry plate this collodion works very beautifully. The film is so tough that it may be washed with a stream of water with rapidity, while there is not the least necessity of resorting to pyrogallic acid as a developer, unless the operator fancies the substance. One great advantage of the xantho-collodion is, that it is ready to produce an intense negative as soon as it is prepared. This collodion is due to Prof. J. M. Sanders.—*H. H. Snelling.*

Xylographs. Positive pictures by the wet-collodion process, toned and transferred from a paper support to a wood block for the production of wood engravings, were called by this name. The manner of preparation is given in Vogel's *Handbook of Photography*, page 233.

Xylography. The art of drawing and engraving on wood.

Xylography, Photo-. (See *Photo-Xylography.*)

Xyloidin. A substance analogous to pyroxylin, produced by the same mixed acids when made to act upon *starch.* It dries from its solutions as a *dead*, not a transparent film. Very inflammable and explosive.

Xylonite. A light vulcanite material, similar to celluloid, employed in making trays and dishes for use in development, etc.

Y.

Yellow Fabric. The non-actinic fabric used for dark-room windows, etc.; it is generally red or yellow. The yellow fabric is obtained by the use of chromate of lead and Paris yellow (lead oxychloride).

Yellow Fog. A fault in the negative, consisting in yellow shadows by reflected light (yellow stain). (See *Fog.*)

Yellow Glass. This article being impervious to white light, is sometimes—and should be always—used to give light to the dark room. The Bohemian orange-yellow is best for this purpose; but when this cannot be procured, ordinary ground glass, colored with an orange varnish, will be found very applicable.

Yellow Prints. From imperfect toning and fixing, or from keeping the sensitive paper too long before printing, prints occasionally become yellow. A solution of bichloride of mercury in water will promptly restore the prints. As soon as the print is bleached it should be well washed in water and re-fixed in hypo. The immersion in mercury must be short, as otherwise every trace of the picture may be obliterated. The intelligent photographer, however, should never have any yellow prints. Dilute aqua ammonia will also frequently give brilliancy to yellow prints.

Yellow Prussiate of Potash. A name sometimes given to *potassium ferrocyanide.*

Yellow Screen. A yellow plate glass or other yellow transparent medium, used when photographing with color-sensitive plates, to weaken the still too actinic blue

light. The picture is taken through the screen, thereby partly obscuring the blue rays. This prolongs exposure about fourfold. (See *Color Photography; Color Screens; Isochromatic and Orthochromatic Photography.*)

Yellow Screen, Substitute for. Vidal recommends for this purpose that the plates be soaked, previous to exposing, in a bath of picric acid neutralized with ammonia.

Yellow Stain. A yellow appearance of the negative by transmitted light, usually caused by prolonged development in pyrogallol or hydroquinone. It may usually be removed, after fixing and washing, by bathing in a solution of 20 parts saturated alum solution and one part hydrochloric acid. When the yellow color shows only by reflected light it is called yellow fog. Collodion negatives and albumen prints grow yellow from insufficient washing after fixation in hypo.

A yellow tinge in the whites of *platinum prints* is caused by the sensitizing solution in the developer not being sufficiently acid, or by insufficient immersion in hydrochloric acid. The remedies are obvious. Yellow stains or mist on *bromide* prints can be removed by the use of diluted hydrochloric acid (1 : 100), or by rubbing the image with cotton-wool in the acid bath before fixing.

Z.

Zapon Varnish. A patented varnish consisting of celluloid dissolved in amyl-acetate. This varnish gives a brilliant surface, impervious to heat or moisture, and may be used for negatives, positives, or as a lacquer for trays. (See *Varnishes.*)

Zinc. The zinc of commerce is obtained from the native sulphuret (*zinc-blende*) or carbonate (*calamine*), by roasting these ores and distilling them along with carbonaceous matter in a covered earthen crucible, having its bottom connected with an iron tube, which terminates over a vessel of water situated beneath the furnace. The first portion that passes over contains cadmium and arsenic, and is indicated by what is technically called "brown blaze;" but when the metallic vapor begins to burn with a bluish-white flame, or the "blue blaze" commences, the volatilized metal is collected. Commercial zinc is never pure. The following method, by which several pounds of chemically pure zinc may be obtained in a quarter of an hour, will be found useful: Melt the zinc of commerce in a common crucible and throw it into a tolerably deep vessel of water, taking care that the metal be very hot at the moment of running. Dry the grains and dispose them by layers in a Hessian crucible, with one-fourth of their weight of nitrate of potash, using the precaution to place a slight excess at the top and at the bottom. Cover the crucible and secure the lid, then apply heat—a vivid deflagration takes place, with great disengagement of light; after which remove the crucible from the fire, separate the drops with a tube, and lastly, run the zinc into an ingot mould. Zinc is a bluish-white metal, having the sp. gr. 6.8 to 7.2; tough when cold, ductile and malleable at from 212° to 300°, brittle and easily pulverized at 400°; fuses at 773° and sublimes unchanged at a white heat in close vessels. It is scarcely affected by exposure to air and moisture. Heated to whiteness in contact with air, it burns with great brilliancy and is converted into oxide (flowers of zinc). It is very soluble in dilute sulphuric and muriatic acid, with the evolution of hydrogen gas. Zinc is used for galvanic batteries, in the manipulation of various articles, in fireworks, and in medicine. Except the use of metal in photo-mechanical purposes, zinc is little used in photography. The salts of zinc, bromide, iodide, and chloride, are formed similarly to the salts of cadmium.

Zinc hypochloride has recently been suggested as a hypo-eliminator.

Zinc, Acetate of. A salt formed by the union of acetic acid with zinc. To prepare, dissolve oxide of zinc in acetic acid, evaporate and crystallize. Or, take crystallized sulphate of zinc, 143 parts; crystallized acetate of lead, 190 parts; dissolve each separately in water; mix, filter, evaporate, and crystallize.

Zinc, Bromide of. (See *Bromide of Zinc.*)

Zinc, Carbonate of. Add a solution of carbonate of soda to another of pure sulphate of zinc; wash and dry the precipitate.

Zinc, Chloride of. Evaporate the muriatic acid solution of zinc to dryness, and transmit dry muriatic gas over the residuum, heated in a tube. When pure, it is colorless, melts at 212°, deliquescent, volatilized at a red heat, and is soft like butter.

Zinc, Cyanide of. Add a solution of cyanide of potassium to another of pure sulphate of zinc; wash and dry the precipitate.

Zinc, Fluoride of. A white compound, scarcely soluble in water, obtained by acting on oxide of zinc with liquid hydrofluoric acid.

Zinc, Iodide of. (See *Iodide of Zinc.*)

Zinc, Oxide of. Take of sulphate of zinc (pure), 1 pound; sesqui-carbonate of ammonia, 6½ ounces; dissolve each separately in 6 quarts of water, filter, mix, well wash the precipitate in water, and calcine it for two hours in a strong fire. Oxide of zinc is white, tasteless, entirely soluble in dilute nitric acid without effervescence; and this solution is not affected by nitrate of baryta, but yields a white precipitate with ammonia, entirely soluble in an excess of the precipitate. Used for all water colors as "zinc white."

Zinc, Sulphate of. Take of granulated zinc, 5 ounces; sulphuric acid, 1 quart; dissolve, filter, evaporate to a pellicle and set it aside to crystallize.

Zinc-Etching. This is the name given to several of the modern processes of reproduction based upon photography. There has been a labyrinth of inventions pertaining to zinc-etching. The best results may be secured by three usual methods: *i.e.*, "swelled-gelatine," "wash-out," and "half-tone." The manipulations are so varied that place for thorough instruction in them cannot be given in a work of this character, and they have been made quite plain in the manuals. The best manual is the first one published, that of W. T. Wilkinson, entitled *Photo-Engraving, Etching, and Photo-Lithography.* The history of zinc-etching is almost as romantically interesting as that of photography itself.

The first experiments were made in 1814 by Nicephore Niépce. By long-continued investigations joined to a highly developed spirit of observation, he discovered that a solution of bitumen spread equally over the surface of a metallic plate, became sensitive to the action of light, and by this action the bitumen was rendered insoluble.

Fizeau, a French scientist, utilized the discovery of the daguerrotype, and obtained by the use of acids the biting of the image. The engraved plate thus obtained could afterward be printed on a copper-plate press. The prints reproduced by this process can be justly considered as the first impressions having a purely photographic basis.

In 1852, the discovery of Nicephore Niépce was rendered more perfect and complete: it was, in fact, at that time that the photographic negative was utilized for the insulation of a coating of bitumen on zinc or on stone. This modification laid the foundation for the first principle of photo-lithography. The first patent was granted to Mr. Fox Talbot.

Two years later, in 1854, Paul Pretsch made the first experiments with the processes based on gelatine. Having recognized all the advantages offered by this substance, his investigations were more particularly directed to the obtaining of a relief on a gelatinous surface. The relief obtained was to be sufficient to be afterward galvanized or stereotyped, then finally printed on a typographic press. This system, still further perfected some years afterward, allowed of the publication of a certain number of illustrated works.

At the start operators were content with making typographical blocks, reproducing line subjects, for example, sheets of music, woodcuts—in a word, everything composed of black lines on a white ground. But soon the efforts and the investigations were directed to the obtaining of half-tones on the typographical blocks, so as to be able to reproduce photographs, wash drawings, oil paintings, etc.

The experiments made by Fizeau in the engraving in hollow lines from daguerrotypes attracted the attention of Fox Talbot, Paul Pretsch, Paul Placet, etc. All these seekers endeavored to obtain in relief what Fizeau had obtained in hollow lines, their object being to substitute typographic impression for copper-plate printing.

This half-tone was with difficulty obtained by means of an artificial grain (first done by A. J. Berchtold) added to the photographic reproduction. This grain, whilst permitting a photographic negative with its lights and shadows to be changed into a block in relief, did not destroy the delicacy of the half-tones and the luminous values. Following those named were the experiments and discoveries of Brown, Barnes and Bell, Asser, Bullock, Swan, Woodbury, Meissenbach, Moss, Ives, Wilkinson, Kurtz, Vogel, Austin, and others, until at this writing we now have fine etchings of the highest grade printed in black

and white and in natural colors. Book, newspaper, and magazine illustration have become revolutionized by zinc-etching, and now zinc has found a fierce compeer in copper, which is largely used as a substitute for it. (See INDEX.)

Zinco Color Work. Suppose we have a landscape with delicate half-tones, and much light and shade, that when received through the ordinary tracing-paper is so indistinct as to be worthless for reproduction in colors. Take fine, strong *tissue paper*. Coat one side with crystal varnish, let it dry, turn and coat the other side, and let it dry. Make crystal varnish by adding spirits of turpentine to Canada balsam until it is thin enough to flow from a varnish brush. Effect the solution by gentle heat.

If not too large, sheets of thick gelatine, such as are used by lithographers, can be fastened to the board upon which the photograph is tacked. The outline may be scratched with a steel point and filled with vermilion dry color, by rubbing with the palm of the hand, and the same may then be turned and transferred to zinc, as many plates as colors to be worked, register-marks and all. A good "safe-edge" must be left all around the margin.

We have, perhaps, an ornamental panel in which we are to place a word. To avoid expense, these are usually kept in stock, one-half only engraved. Take China cheesing-paper; coat the same with starch just "jellied," rub in all directions with a sponge. Let it dry. Pull a transfer well inked up with ink as stiff as can be worked. Now take this copy, place another piece of clean paper, carefully place the coated side next the inked image, place on smooth stone and pull through with medium pressure. There will result a *reversed* fac-simile. The two may now be carefully joined and put down upon the zinc, pulled through, and a perfect original obtained. The desired word may be inserted before doing so, or it may be drawn in with ink afterward.

Suppose we have a word set in type. We desire this to show white letters upon a solid crimson or scarlet ground, or we wish to gild the panel in solid bronze before printing the word. We must have a perfect fac-simile in white. We secure this in a few moments at no expense, thus: Pull an impression of the word in strong ink, dust it over with equal parts of finely powdered gum-arabic and dextrin. Place in a damp box until sticky; then lay it face down on the zinc, and pull through. Protect the margin with gum. Roll up with greasy ink. Wash well with water and soft rag, when the gum and dextrin will come away. Gum up and let dry.

A head is to be crayoned on zinc or process paper. Enlarge in a camera, or, if life size, make a bromide. Trace on gelatine as before. Now this will secure you an outline for as many color-stones as desired, each a fac-simile of the others. The "lay-to" or register-marks can be secured by marking with the edge of a silver coin.

If a show-card, the words may be gummed out and some ink mixed and spattered by means of a tooth-brush and comb, where desired for effect. Suitable crayons may be made of lamp-black, soap, wax, and spermaceti.

		L.-b.	*S.*	*W.*	*Sp.*	
No. 1.	(Works freely)	2	6	4	0	parts
" 2.		2	4	8	0	"
" 3.	(Less freely)	2	4	4	4	"
" 4.		2	4	8	4	"

Melt, mix, and pour in a druggist's pill-mould, 12 grooves. Remember that the zinc and paper also must be protected by hand-rest and card under a parallel ruler. Point the crayons with a sharp knife by laying the point on the left forefinger and cutting *toward* the wrist. It will be well to have half a dozen pointed at a time. If many straight lines occur you will do better to cut the crayon *wedge shape* than to a round point, and *push* as well as draw the crayon to the ruler.

While drawing, the porte-crayon must be constantly rotated by *depressing the thumb*. Accents of pure black can be put in with a brush. Do not blow upon paper or zinc, or spittle spots will spoil your work. Use a flat brush. It is, of course, understood that upon process *paper* the drawing need not be reversed. Upon zinc it must all be done backward and judged in its progress by a mirror reflection.

Colors for show-card use, called *permanent:*

White.
Zinc White.

Blue.
Ultramarine.

Yellows.
Yellow Ochre.
Raw Sienna.
Cadmium Yellow.

Reds.
Vermilion (Chinese).
Red Ochre.
Indian Red.
Venetian.

Browns.
Raw Umber.
Burnt Umber.
Burnt Sienna.

But if shut in a book the list may be much extended:

Reds.	*Blues.*
Crimson Lake.	Prussian Blue.
Scarlet Lake.	Oriental Blue.
(No Geranium, as it fades.)	Chinese Blue.
Purples.	*Orange.*
Purple Lake.	Orpiment.
Mauve.	

Don't mix the following with *flake white:* Indian yellow, yellow lake, orpiment, crimson or other lakes, carmine or indigo.

Dont mix any of the non-earthy colors with silver white, King's yellow, carmine, or scarlet lake.

The following are fine finishing colors because transparent: Raw sienna, Indian yellow, Italian pink, madder lake, crimson and scarlet lakes, cobalt blue, Vandyke brown, burnt umber. A little Prussian blue in burnt umber will accent more neatly than black. Dont use black in color work. Bronze always first. Blue over yellow makes a *dark cool green*, but yellow over blue gives a warm light green. A crimson lake over blue gives a much richer purple than the reverse. We may then say, bronze first, blue second; third reds, fourth yellows, fifth the finishing browns.—*C. Ashleigh Snow.*

Zincography. Almost all the methods of producing printing-blocks in line, stipple or half-tone on zinc are included under this generic name. During recent years copper has been largely substituted for zinc as a base in the half-tone processes. A full description of these processes may be seen by reference to *Wilkinson's Photo-Engraving*, etc.

Zincography, Electro-. (See *Electro-Zincography.*

Zincography, Photo-. (See *Photo-Zincography.*)

Zincographic Process (Lumière's). This new method is a modification of the albumen process. The following solution is prepared:

Water	1000 parts.
Albumen of Eggs	100 "
Bichromate of Ammonia . . .	3 "

Ammonia sufficient to produce a bright yellow color.

The mixture is strongly agitated, filtered with care, then spread by means of a revolving disk over a polished zinc plate previously cleaned with whiting. As soon as a thin, even albumen film is obtained, it is necessary to hasten the drying by slightly heating the plate. It is afterward exposed to the light under a positive, then, the exposure being judged sufficient, the zinc plate is removed from the frame, and coated by means of the roller with a slight layer of transfer ink, to which medium varnish has been added. The quantity of varnish to be added must be found by experience. The appearance of the coating should then be dark-gray, without any visible sign of the image, and not black. After immersion in tepid water the print soon shows itself, and it may easily be cleaned by lightly rubbing the surface of the zinc with a tuft of cotton. The image thus obtained is a negative, and the metal is exposed in the parts representing the black lines of the original. The albumen, in fact, has remained soluble in the parts protected by the corresponding lines of the positive screen during the exposure to the light. The plate is then rinsed in abundant water, dried, and plunged into a solution of perchloride of iron at 35° Baumé, in which it is allowed to remain for from ten to fifteen minutes. It is washed and then dried. By afterward passing over the zinc, heated to about 122° Fahr., a roller coated with an ink composed of transfer ink and medium varnish, the ink adheres to all the surface, and we obtain in this manner a black picture; the background is then freed by means of a smooth roller passed rapidly and frequently over the plate. The coating is now rubbed with a piece of soft rag soaked in caustic ammonia. The image appears in black, detaching itself from the brilliant background formed by the zinc. During this operation the bichromatized gelatine, rendered insoluble by the light, is in its turn dissolved in the ammonia, and thus is obtained a second development, the reverse of the first. By the rubbing and the aid of the ammoniacal liquid, the ink is removed from the parts where it was supported by the insoluble albumen, while this ink remains attached to the zinc in the engraved portions. It is this last reaction which is the basis of the method, and which constitutes its novelty. We may add that it is very curious to witness this inversion of the primitive image under the action of the ammonia. The solution of potash, soda, etc., or of their carbonates, do not give such good results, probably on account of the saponification of certain elements entering into the ink used, and also

because these substances do not possess the considerable diffusive power of ammonia. If the plate is to be used in a lithographic press, nothing remains to be done but to prepare it in the ordinary manner by means of the gallic, phosphoric, or chromic solutions. If, on the contrary, it is to be placed in relief, it is necessary to dust the image with pulverized rosin, then to heat as usual before proceeding to the first biting. In this last case it is preferable to shorten the time of the immersion in the perchloride of iron, so as to avoid the formation of too apparent lines in the portions which finally are to be in relief.

Zinc Tanks for Washing Prints. We know that the hyposulphite which is deposited at the bottom of zinc tanks used in washing negatives and prints attacks the metal. It results from this that the tanks are injured and that the prints attached to the bottom are spotted. These objectionable features may be avoided by a *varnish* consisting of 5 parts of bitumen of Judæa dissolved in 100 parts of benzine. This varnish is spread as in collodionizing a plate, in artificial light; then the tank is exposed to sunlight, which renders the bitumen insoluble. It is well to give two coatings of this varnish and to renew the operations when it commences to wear off. For gelatino-chloride prints, which generally remain at the bottom of the tank, it is well to place at the bottom a wooden frame about two centimetres in thickness on which is stretched a network, thus retaining the prints in the portion of water not saturated with hyposulphite. For this purpose may also be used enamelled iron plates of various sizes, perforated, and furnished with small feet.

Zircon Light. Zircon is a mineral consisting of zirconia and alumina. Zircon has been used as a substitute for lime with the oxy-hydrogen light, and with small sticks of magnesia it gives a very intense light.

Zoöpraxiscope. An instrument used to exhibit studies of animals in motion, by which several pictures, taken instantaneously in succession, are made to show the subject in continuous movement, being similar to the zoetrope of Anschütz, and employed for the same purpose.

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